PART 2

PARTICULAR INSTRUMENTATION, CONTROL AND AUTOMATION REQUIREMENTS OF IOT BASED INTEGRATED PERFORMANCE MANAGEMENT SYSTEM

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PART 2

Project Requirements- IPMS, Field Instrumentations, Control & Automation

2.1 Introduction

This part covers the particular requirements for the design, supply, installation, inspection and testing of the Integrated Pump Performance Management System, Field Instrumentation, Control and Automation System, associated Pumping Stations and allied Systems and materials.

2.2 Purpose

Bengaluru Water Supply and Sewerage Board (BWSSB) is the heart of overall water supply for the city of Bengaluru. The BWSSB infrastructure plays a critical role in providing required water supply to the city of Bengaluru. Monitoring and timely maintenance of critical water utilities infrastructure plays a crucial role in not only in providing continued water supply to the citizens but also in increasing the life of the utility's infrastructure.

The purpose of this proposed solution is to provide the timely information and also predict any failures in critical water utilities infrastructure. The purpose of this document is to outline the requirements and their specification to monitor the Pumping stations of Stage IV Phase I and provide insights to the Board to take preventive actions. This document will provide detailed list of requirements in the subsequent section and expects the bidder to provide a solution to meet the requirements functionally and technically.

Vision statement of the project is to improve Operating Efficiency and Sustaining Performance, Leveraging Technologies and Best Practice Leading to Improved Service Delivery of Pumping Station. Therefore, the solution itself is named as **"Integrated Pump Performance Management System (IPMS)".**

Below are the several purposes of the proposed Integrated Pump Performance Management System. Hereinafter referred as "IPMS".

Also wherever IOT is mentioned in the tender documents, same is required to be Industrial IOT (i.e. IIOT).

2.2.1 Monitoring of Pumping stations and their assets

Pumping station broadly consists of 4 components, Reservoir, Pumps & Motors, pumping main and Surge tanks, where monitoring and reporting is required.

Further same is discussed in detail in next Sections,which also addresses on a high level what is the expected output of the monitoring solution.

2.2.2 Reservoir Monitoring

Reservoir is the body that gets connected to the perennial water source i.e., Cauvery River and this water is treated and then pumped to the upstream reservoir, in this case, TK Halli is the first reservoir followed by Harohalli and Tataguni. All these reservoirs are connected to each other and any disruption in the down stream Pumping station will impact the upstream Pumping station as well and in turn the public at large. Reservoir monitoring need to be done at various levels that will be mentioned in the Functional requirements of IPMS.

2.2.3 Pump Monitoring

Pumps are the one of the crucial part of the BWSSB and therefore requires monitoring at all the levels. Considering the installation details in section 2 – Pumping station Details of IPMS Chapter, this tender expects the bidder to provide exhaustive pump monitoring solution with overall SCADA system with IIOT based monitoring as detailed in Functional and Technical Requirements of IPMS of this document. This will include all capturing critical parameters of the pump and the motor along with water related parameters.

2.2.4 Pumping Main monitoring

Pumping main is the pipeline that transmits water from the Pumping station to the next Pumping station or to a reservoir. This is the critical part of the BWSSB and needs monitoring for critical parameters like flow and pressure. While the summation of the water discharge lines coming from each of the pumping set in the Pumping station will provide the details on how the Pumping main is performing, it is important to monitor and report on the status of Pumping main as well.

2.2.5 Surge tank monitoring

All the Pumping stations is required to have surge tanks in place. Primary purpose of surge tank is to help maintain a constant back pressure, measure the flow rate and also use for storage. Therefore, measuring of these parameters and reporting it to the BWSSB is of paramount importance.

2.2.6 Localized and Remote Monitoring including asset monitoring and reporting

Considering the importance of asset monitoring and reporting within this tender it is called out clearly as what is required for localized monitoring and remote monitoring. Both the levels of monitoring are crucial and all kinds of alerts and notifications are provided to various levels within BWSSB. Requirement of reporting and SLA monitoring to measure the performance of the pumping stations is clearly documented in the tender.

2.2.7 Hardware and Software requirement

As a inherit requirement to monitor the pumping station and report is locally and remotely, there are a list of instrumentation, hardware and software requirement that needs to be complied for providing any solution. Details of instrumentation, hardware and software are provided in Technical Specifications of the IPMS Chapter.

2.2.8 Dismantling of existing ICA items including its relevant Cables

Under this Tender scope, Existing Instrumentation Control and Automation related Panel, Devices, Cabling and other applicable items to be dismantle/removed to facilitate installation of newly designed SCADA system. This activity shall be a pre-requisite to initiate any procurement activity under this Tender's scope work.

2.2.9 IOT Based IPMS / SCADA – Significance of Control& Automation

At present conditions, although monitoring of Pumping Station & allied system's is a prime objective however it is a minimum requirement of the project that word "Control" means sending the alarm, alerts to BWSSB officials/station operators, if there is any kind of deviation from normal operating range.

* However as per the complete project requirement, Bidders are also required to consider IOT based SCADA System in line with the minimum line items as per the Technical Schedule wherein below is the requirement as far as Control & automation part (SCADA) is envisaged.

* IOT based IPMS / SCADA proposed herewith shall be future ready wherein present manual operation of Pump sets are proposed to be operated remotely in both Auto & manual mode.

* Hence proposed IPMS shall be able to operate the pumps remotely (at least tripping of pump sets is envisaged as & when required based on IPMS control output).

* Also auto/manual operation of pump sets, selection of working / standby, Local/Remote operation shall be possible from the Touch Screen Pump Monitoring Station for Individual Pump sets & IOT Station (as a future provision).

* (Hence word “SCADA” used in tender refers to the above requirement only).

* Part I (General Requirements)&Part II (Particular Requirements) covers the specifications of all the possible items related to IPMS however Technical Schedules indicate minimum requirement which is minimum and mandatory.

However, Bidders proposing IOT based IPMS solution shall propose equivalent of PLC-SCADA system as per technical Schedule.

Bidders to submit the Operation & Control Philosophy for both the cases in the Bid documents.

2.3 General

This section outlines the particular requirements forIPMS,FieldInstrumentation, Control &Automation works. This section shall be referred in conjunction to the general requirements for instrumentation, control and automation works specified in this document. Unless specified in this section to the contrary, the system provided by the Contractor and workmanship shall comply with the General Chapters of these Requirements.

The scope of IPMS, Field Instrumentation, Control and Automation (ICA) works for 3Water pumping stations located at T.K Halli, Harohalli&Tataguni and also Surge Tank Instrumentationincluding JK Doddi, shall comprise the design, manufacture, programming and configuration, off site testing, delivery to site, installation and erection, testing, commissioning, setting to work and provision of documentation for a complete and reliable supervisory, instrumentation, control and automation system including the interfaces required to provide monitoring and control for a safe and efficient operation of the entire system.

Note: The contractor shall provide the ICA equipment as indicated in Technical Schedule-I, II & III of this contract as a minimum respectively for T K Halli, Harohalli&Tataguni CWPS of Stage 4 Phase I.

The Contractor shall submit and obtain approval for all ICA equipment from the Employer'sRepresentative before beginning the detailed control system design. Refer approved vendor list for instruments and automation. The contractor shall note that the approved vendor list indicated in particular requirements is only for the product and not for executing agency to execute the work. The contractor shall submit the credentials of the agency which shall be executing the work for review and approval as per qualification criteria indicated in the general requirements herein.

At the time of bid submission, the contractor has to submit the completed technical schedule of the proposed instruments as per the technical schedule. All relevant manuals should be attached. Failure to adhere to the above would be treated as a non-responsive bid and lead to technical disqualification. The contractorshould take note of the importance of this obligation.

Deviations for More Stringent Requirements

Where the requirements of the standards cited in both Part 1 i.e. General Requirement and Part 2 i.e this document are more stringent in any respect than the requirements of the standards, in the opinion of the Contractor, the proposed manufacturer or any manufacturer or dealer or supplier in the country reasonably cannot meet these more stringent requirements, then the Contractor shall submit to the Employer's Representative for approval a list of all the deviationsfrom the standards cited in the Contract in bid submission / after the award of the contract.

If requested to do so by the Employer's Representative, the Contractor shall submit to the Employer's Representative at least one copy of each code of practice, standard, and reference work which is referred to in the general technical specifications or elsewhere in the Contract or proposed by the Contractor. All such documents shall be in the language stated in the Contract Data in accordance with the "Conditions of Contract".

The Employer's Representative reserves the right to reject any Plant or Materials manufactured to a different standard which he considers to be unacceptable.
The project delay out of this activity shall be on account of Contractor.

Codes and Standards

The Works shall be designed, manufactured, constructed, tested and operated in accordance with the standards and codes of practice, also indicated in Part 1 General Instrumentation Control and Automation Requirement of IPMS. In the event of differences between the standards or codes of practice or the tender documents itself, the more stringent shall apply.

2.3.1 Minimum scope of ICA work for the three CWPS

The minimum scope of ICA work for the three CWPS (Including Surge Vessel & JK Dodi Instrumentation)shall include but not limited to:

a. Design, supply, install, test and commissioning a Pump Performance Management System using Machine Learning, Artificial Intelligence and most importantly Digital Twin Virtual pump shall include but not limited to Web based Fully Pump Performance Management Solution and Remote Data management Cloud Software License with all accessories and fixtures, Edge Hardware with all accessories and fixtures, Touch Screen Pump Monitoring Station for Individual Pump with all accessories and fixtures, Mobile App. for Android and Apple, Common Touch Screen Data console, Smart LCD Screen, Various Sensors etc.

b. Design, supply, install, test and commission new Sensors, Elements on Existing Pump & Motors for the three CWPS. NOTE: Every Bidder to visit all the 3 CWPS Sites & carry out feasibility study of installing new sensors on existing Pumps-Motors (ensuring correct measurement in line with standards, approved practices). Compliance Report of the same shall be mandatory part of Bid Submission.

c. Design, supply, install, test and commission field instrumentation for the three CWPS including Surge Vessel Instrumentation and J.K. Doddi Instrumentation.

d. Design, supply, install, test and commissioning uninterrupted power supply /24VDC system to meet the power supply requirement of theentireIPMS;

e. Interface equipments to enable communication between 3 CWPS, J K. Doddi and subsequent User interfaces through GPRS Cloud application.

f. Control console for placing workstations and printer compartments, desk for Workstations, The system console design shall be submitted to Engineer for prior approval.

g. Dismantling ofexisting Instrumentation Control and Automation related Panel, Devices, Cabling and other applicable items (to be dismantle/removed to facilitate installation of newly designed IPMS).

h. The Contractor shall be responsible for the design of each instrumentation and plant monitoring system, including the selection and design of appropriate transducers(on approval by the client's representative), transmitters, signal conditioning devices, indicators, alarm account in his design of all installation and environmental conditions prevailing at each CWPS site.

i. All the drawings of tender documents will also be a part of the Scope of work.

j. Design, supply, install, test and commission a standalone IOTUnit for J.K Doddi. The system shall include on a minimum, redundantcommunication, UPS etc.

k. Design, supply, install, test and implementation data communication to the WTP Control System and other packages (CP-24& MIS-2 SCADA) as required inclusive of bulk data transfer of all operational data via redundant GPRS communication network and via redundant FOC communication network(FOC network shall be established under separate contract package CP-24).

l. Design, supply, install, test and commission uninterrupted power supply system with 120 mins backup on full load, to supply the entire IPMSand field instrumentation, vendor packaged control system and associated instrumentation, communication interface consisting of RTU, GPRS modems & FOC equipment (to be supplied by Centralized contractor).

m. Control room furniture include but not limited to control system consoles for placing servers, workstations and printer compartments, Workstation and printer compartment and ergonomic designed seating systems.

n. The contractor shall ensure that complete CWPS& JK Doddi operational data, all SCADA mimics inclusive of the IPMS data is made available to the FOC integration panel, which shall be installed under the centralized SCADA package (CP-24) for onward transmission to the centralized SCADA center. In

addition to the same, the contractor shall transmit the operational data via redundant GPRS communication equipment (to be provided by the contractor) to MIS-2 SCADA and Cauvery Bhavan. GPRS communication system shall function as backup mode of communication to the FOC communication (FOC to be set up under CP-24).

o. All necessary required cabling, programming, software and hardware required to make the data available to the above-mentioned contracts at all times, is part of the integral scope of work of the contractor. The contractor shall co-ordinate in full and conduct interoperability tests with the centralized SCADA contractor to ensure data is compatible with the data format which is required at the integration panel end.

NOTE : No variation shall be accepted as far as the project requirement is concerned i.e. Integrated Pump Performance Management system shall be IOT Cloud Server Based having combination of (a) basic Metering supported by IOT Sensors with data acquisition arrangement and (b) advanced analytics platforms, using Digital Twins & Artificial Intelligence and advance Machine learning.

2.4 CONTROL SYSTEM – DESIGN & CONSTRUCTION FOR IPMS and associated control & Automation System

CONTROL SYSTEM – DESIGN & CONSTRUCTION FOR IPMS and associated control & Automation System (Inclusive of Cloud Server based intelligent Platform, Local PLC, RTU – SCADA)

i. The control system shall be based on the use of IOT Cloud Server Based Intelligent Platform.
It should be Industry grade console (Kiosk) at each pump with live display of its key various parameters including efficiency.

ii. The control systems shall recover fully to a normal operational state on restoration of the power (either from the mains or the generator) after a power failure without manual intervention. (i. e. to remove doubt this requirement refers to a real failure of power to the control system such as would be experienced if the control system UPS s were not present).

iii. The control systemshall be deigned with a combination of both manual and automatic mode of operation.

iv. In all cases, facilities shall be provided to permit automatic controls to be overridden and the systems to be manually controlled.

v. Local manual controls shall be located adjacent to Pumping Stations where required for day to day operation. All drives essential for the continuous operation of the Pumping Stations shall be provided with a standby.

vi. The process control system must be state-of-the-art in terms of structure and function as a process information and control system and its hardware and software must be future-oriented. The control system should be a modern system with an appealing user interface, open to the office and process world, with sophisticated and reliable functions, efficient to configure and scalable for simple and complex tasks.

vii. The communication channels modules for the connection to the Programmable logical controllers via various communications media must be included in the scope of delivery of the control system, the same applies to drivers for simple types of coupling such as point-to-point via the MPI interface. In addition, it should be possible to establish the coupling to other devices and applications from various manufacturers via the standardized software interface OPC.

viii. One of the method by which cloud and edge/RTU should be connected at higher bandwidth *(say 40MBPS and above) as far as User Interfaces through GPRS Cloud Application is concerned.

ix. Data Retention : Data shall be stored in cloud is up to 2 years.

x. CCTV / WebCamera data storage is not required in the cloud. Same can be stored in local drive.

a) Integral online parameterization option

A prerequisite is a comprehensive parameterization system that is integrated in the system, which allows the user to adapt the scope of functions and the functionality to any changed requirements without any programming expertise. The system must offer the option for carrying out these parameterization operations online. In

practice, this means that the respective editor can run in a second window during operation and the configuration engineer can make changes to his application without exiting process mode and also without affecting the background activities. In addition, it should be possible to make configuration changes on the client as well.

2.5 Hardware

The control system hardware shall consist of field controls which comprises on a minimum but not limited to:

- PLC s;
- Redundant power supplies;
- Panel HMIs;
- Alarm annunciators
- field cabling interfaces.
- Redundant communication equipment
- Pump performance monitoring systemand central controls which comprises:
- Redundant SCADA server and auxiliaries;
- engineering station& operator station;
- historian station;
- ––55” inch touch screen video display
- Un-interruptiblepower supply.

The site instrumentation shall also form an integral part of the control system.
The equipment detailed in the aforementioned field controls list (with the possible exclusion of the power supply) and some components of the instrumentation system shall be housed within a number of control panels (CP s). Each panel shall be located adjacent.

The control panels shall provide separate areas for the PLC, internal power distribution, instrumentation, field cabling and for any surge (lightning) protection devices (SPD s). A separate instrumentation earth (a ‘clean’ earth) shall be established within the control panel. Instrumentation and control cable screens shall be connected to this earth.
The complete IOT based SCADA system inclusive of the IO systems shall be housed in AC environment.

2.6 Power Supply

The Instrumentation and Pumping Stationscontrol system shall be powered from online uninterruptible power supplies (UPS). These shall be sized to provide sufficient power to maintain the Instrumentation and Pumping Stationscontrol system (inclusive of allfield instrumentation, IPMS, FOC & GPRS communication equipment, all vendor package instrumentation) systems functioning for a period of not less than 120 minutes on full load.

The status & online parameters of UPS shall be monitored from the SCADA system and an alarm raised via the control system if a fault occurs or the UPS battery supply is about to expire.

2.7 Voltages

The following control voltages shall be used:

Item	Voltage
1. within starter enclosures	240 V AC
2. instrumentation power supplies	240 V AC / 24 V DC
3. PLC inputs cards	24 V DC
4. PLC outputs	24 V DC

2.8 Control System Protection

1. Short Circuit

All circuits shall be protected against short circuit by the provision of adequate numbers of fuses or miniature circuit breakers.

For ease of maintenance and system security power supplies to each instrument loop and each PLC output shall be protected with an individual fuse (terminal type).

2. Surge Protection

Surge protection devices (SPDs) shall be provided at the control panel end of all instrumentation and control cables which run for distances in excess of 50 m outside the confines of the building in which the CP is housed. The SPD s shall be grouped in a specific area within the CP to ensure ‘dirty’ signal cables do not come into direct contact with ‘clean’ signal cables.

3. Duty / Standby Drives

The duty pump for each duty / standby pair shall be selected at the local control panel and the Pumping Stations HMI.

The control logic shall automatically start an 'available' standby in the event of the duty drive failing. The new duty drive shall take on the role of duty drive in all respects and shall continue to run as duty until manually reselected to standby or it fails.

1. Interlocking

Hard wired interlocking shall be provided for safety circuits such as:

- motor protection;
- run dry protection;
- emergency stop circuitry;
- rotation monitor.

In addition drives stopped as a result of the action of hardwired interlocks shall in addition have a fault signal conveyed to the drive in order that the PLC drive run output is removed.
Soft wired interlocking is provided by the PLC for process control and for safety trips when the signal is derived from a remote source (e.g. stopping of the pumps as a result of a high level in a downstream clearwater reservoir).

2. Alarm Annunciation

Alarms shall be annunciated at three locations, at the drive starter, at the local RIO HMI and at the central SCADA. A philosophy shall be adopted that all alarms associated with a drive shall be annunciated at the starter whilst a general alarm only for that drive shall be enunciated at the HMIs. Therefore the operator observing a general alarm at an HMI shall have to go to the starter concerned to determine the exact cause of the alarm condition.

A typical alarm schedule is detailed in below table.

Table: Alarm Schedule

Device	Alarm at the Starter/Panel	Alarm at the relevant local and central SCADA

1. Power System		- transformer fault - mains incomer tripped - generator incomer tripped
2. Pump and blower drives	- overload (see note 1) - earth fault (see note 1) -emergency stop operated -run dry protection operated	- drive fault (see note 2) - to be decided during detailed engineering
3. Valve actuators	- drive fault	- drive fault - to be decided during detailed engineering
4 Clearwater reservoir level		- high high water level - high water level - low water level - low low water level
5 Pumping main pressure		- high pressure
6 Surge Tank level		-high water level
7. Control system		- SCADA to PLC and PLC to PLC communication faults (various)
8. UPS s		- fault - battery low
9.Communication failure		-Communication failure between all 3 sites, J K Doddi, Cloud based Server

Notes:

1. These alarms may be displayed on the motor starter panel. If this is flush mounted further individual indication may not be necessary.
2. These alarms are derived within the PLC from the analogue level value.
3. The Contractor shall provide alarms necessary for the proper and efficient operation of the Pumping Stations.
4. The above mentioned alarms are indicative only of the number and type of alarms that are required. The Contractor shall provide the above alarms on a minimum and other alarm necessary for the proper and efficient operation of the Pumping Stations.

3. Communication Monitoring

The control system shall continuously monitor LAN communications and raise an alarm at the central SCADA, Cloud based Server System, & relevant User Interfaces through Web & Mobile Application. if communications should fail between the SCADA and a controlling PLC/RIO or between PLCs if inter-PLC communication is being used.A separate SCADA screen (mimic) showing the real time status of PLC's, I/O modules, LAN communication, RIO status, etc. is to be incorporated.

2.9 Integrationrequired under this contract with other contracts& communication methodology to be adopted under this contract

Integration required under this contract with other contracts & communication methodology to be adopted under this contract (apart from Cloud based Server IPMS Solution & subsequent User Interfaces like Web & Mobile Applications)

Scope of Work for Integration & communication between sites:

1) Data from the CWPS is required to be transmitted to the T K Halli WTP control system for use in its control and also receive the data communicated from the WTP control system.

2) Data from the CWPS is required to be transmitted to the Harohalli&TataguniCWPS for use in its control and also receive the data communicated from the WTP control system.

3) Data from the CWPS is required to be transmitted to the Centralized SCADA center proposed under contract package (CP-24) for use in its control & monitoring and also receive the data communicated from the CP-24 centralized SCADA system to be displayed at its end.

4) Data from the CWPS is required to be transmitted to the MIS-2 SCADA located at Shimsha Bhavan for use in its control & monitoring and also receive the data communicated from the MIS-2 system to be displayed at its end.

5) The Contractor shall provide all facilities to output from the control system via redundant GPRS communication system and redundant FOC communication equipment, the discrete signals to be sent and to accept the discrete signals provided.

6) The Contractor shall provide a suitable cable route to the CWPS building control room; to facilitate the FOC communication cable integration with the Pumping StationsIOT based SCADA system.

7) The Contractor shall provide termination details to permit these connections to be carried out. The Contractor shall co-ordinate in full with other Contractors of other packages to interface with CWPS control system so that the entire SCADA system for water supply system can be provided completely.

Interoperability Test & Integration co-ordination:

1) The CWPS contractor shall conduct a interoperability test to confirm & demonstrate that the local control system data can be read & written by the control center atCP-24 and MIS-2 atShimshaBhavan using appropriate OPC server & client software.The contractor shall submit Interoperability test documentfor each site for review and approval. The same shall be demonstrated during control system FAT. Final interoperability test shall be carried out in presence & co-ordination with the contractor of respective packages as indicated in this clause.

2) It is required that the CWPS contractor maps his I/O’s for integration in the format as required to complete achieve complete integration and to

communicate and receive data as required. The contractor shall transmit complete Pumping Stations data as a minimum requirement under this contract.

3) The CWPS contractor shall co-ordinate fully with the respectivecontractor for integration tests. TheCWPS contractor shall be fully responsible for data to be made available for integration at the FOC communication equipmentend at all times,(to be installed by CP-24 contractor).

4) Bulk transfer of data to the FOC integration panel at CWPS and J.K Doddi (FOC to be installed and commissioned by the centralized SCADA contractor under Package-014)

Communication Methodology between sites/locations /contracts to be adopted under this contract:

1) The contractor shall note that GPRS communication system shall function as the primary mode of communication till such time the FOC communication network is established under contract package CP-24.Once the FOC communication network is established and commissioned, GPRS mode of communication shall act as backup mode of communication to FOC communication network.

2) The SCADA & communication interface shall be so designed to switch between FOC and GPRS mode of communication automatically on pre-defined intervals in order to cross verify the readiness and working of the communication system at all times.

3) The frequency of switchover shall be minimum 2-3 times in a week. The switchover philosophy shall be detailed in the FDS.This shall be in co-ordination with control system of MIS-2 and CP-24 packages.

4) Co-ordination and interoperability testing betweenCP-24& MIS-2 shall be under the scope of the contractor. Contractor to note the importance of this clause.

Minimum Data to be provided by the CWPS Control System but not limited to:

The CWPS contractor shall provide complete SCADA screen dumps with all data, to enable complete CWPS monitoring from the Centralized SCADA Centre.

The typical data are tobe transmitted by the Contractor to the interface on a minimum but not limited to:

- total flow / day (Ml);
- power outage hours / day (h);
- power outage at pumping station ~~works~~;
- Complete Pumping Stations maintenance record.
- Complete Pumping Stations operational data;
- 2 Nos CWR levels at T K Halli (analogue signals as a percentage full);
- T K Halli CWR high high(OR gate of either half of the CWR)
- T K Halli CWR high (OR gate of either half of the CWR)
- T K Halli CWR low (OR gate of either half of the CWR)
- T K Halli CWR low low (OR gate of either half of the CWR).

2.9.1 System Completeness

This section of specifications defines the particular requirements of instrumentation, control & automation works to be installed.

Irrespective of the detailed specifications of the respective items detailed in the various chapters of the tender specification, the Contractor shall be required to provide all the equipment, accessories, cabling, earthing, providing necessary transducers/sensors, system hardware/software, programming logic, interlocks,cabinets, panels etc. to achieve the functional requirements described in the Bid Document.. The System completeness shall be the Contractor’s responsibility.

Note: In FAT, all the field instruments shall be tested for functionality as per contract requirements at the manufacturers work location where the equipment is manufactured. Quality assurance plan (QAP) shall be submitted along with the datasheets for review and approval before any inspections call is initiated.

2.10 Field Instrumentation and Control

Each field instrument shall be operable in local mode and have display functions in SCADA. TheContractor shall be responsible for providing the appropriate signals at the locations required to provide the specified control and monitoring functions.

The Contractor shall ensure that field measuring systems shall respond quickly to any changes of the measured process variables.

All field instruments shall, as far as practicable, be mounted in a location that shall be free of vibration and shall be powered from the instrument control system.

24V dc power wiring for field instruments shall be individually fused and provided with a means of disconnecting the power without disturbing terminated wiring (e.g. knife-switch-type terminal blocks). Visual indication of a blown fuse condition shall be provided.

All field instrument components shall be of a proven and reliable design and shall have a high degree of uniformity and shall, wherever possible, be interchangeable. The design shall facilitate easy maintenance and repair, taking into account the availability of access routes through Pumping Stations and structures generally.

Field Instruments shall perform sensing, indicating, transmitting and controlling. The devices shall generally interface with the SCADA, either directly or indirectly. The materials of those parts of the field instruments, including piping material, which are exposed to the measured media shall be compatible with the conditions of the respective media and of the ambient fluid and atmospheric conditions.

All field instruments shall be mounted within enclosures that are corrosion proof, dust proof and waterproof to provide a minimum protection specified in elsewhere in this Specification. The enclosure shall be rated to minimum IP 65. The enclosure design shall be submitted along with the instrument datasheet for review and approval before any design of the same.

All field instruments, including the components, shall be tropicalized and designed for the ambient conditions detailed elsewhere in this Specification. Lighting protection barriers shall be used for protecting transmitters and receiving instruments from the surge voltage due to lighting strike. Lighting protection barriers shall be supplied at both receiving and sending ends for all signals from outside building and those installed between the buildings.

2.11 Design Requirements for Instrumentation, Control and Automation Requirements

2.11.1 Minimum Design Consideration

The instrumentation, control & automation system shall fully comply with design standards, regulations and the material and workmanship requirements of the Specification.

The electrical plant installations associated instrumentation control and automation systems shall also comply with and be tested in accordance with the latest edition of BS 7671 or equivalent Indian standards.

All equipment and materials incorporated in the system shall be selected, designed and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability.

The instrumentation control and monitoring system equipment and materials shall have an operational life of not less than ten (10) years.**The system integrator shall provide technical services/support for 10 years without extra cost, excluding spares.**

Instrumentation, Control, Automation system shall be designed, manufactured and installed to achieve the following basic requirements:

- to maintain the highest standards of availability, reliability and accuracy and to give clear warnings of any deterioration in performance;
- to suit the abilities of the staff who will:
  - use the systems;
  - service the systems;
- to measure, indicate, process, store and control the relevant parameters, as specified;
- to give clear warnings of dangerous and other abnormal conditions and to initiate plant safety procedures, shutdowns and corrective measures as specified to assure the safety of ‘operations and maintenance’ personnel and plant and to store and collate the data, as required;
- to derive, present and utilize, as required, such additional data as required to facilitate:
  - the most efficient operation of the plant;
  - the routine maintenance of the plant

Equipment and system shall be designed and constructed to perform accurately and safely under the environmental and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion.

Equipment and systems shall be supplied as per the vendor list indicated in specification elsewhere.

The equipment, systems and accessories furnished shall be designed and constructed to meet the performance specification during the continuous service life of the plant.

Contractor shall indicate the year in which the offered models of the instruments and control system have been introduced and how long the commercial production of the same is expected to continue. In any case, Contractor shall ensure supply of spare parts for minimum period of ten years. In case if it is felt by Contractor that certain equipment/ component is likely to become obsolete, Contractor shall clearly bring it to the notice of Employer and indicate step proposed to deal with such obsolescence like maintaining “bonded spares” with the manufacturer/s.

Any part/ module of the C&I system which are not listed under recommended spares shall be deemed as having life expectancy not less than ten years.

Contractor shall supply proven latest version of hardware and software available at the time of system designing. In case of future up-gradation of software, Contractor shall remain committed to upgrade the supplied system at per with the new version within the warranty period and O&M period and ensure successful integration of the system.

For the sake of completeness of the system and in order to ensure desired performance & safety measures, any hardware or software item felt required, shall be in the scope of Contractor irrespective of their explicit or implicit inclusion in the accompanying document.

Technical details furnished in the accompanying documents are subject to change in future within reasonable limits, which Contractor shall abide by.

2.11.2 Instrumentation Design Criteria

The design criteria to be applied to instrumentation systems shall be as follows:

1) all instruments shall be suitable for continuous operation;
2) all transmitting instruments shall have a 4 - 20 mA linear output;
3) all digital outputs shall be volt free;
4) all instruments shall be designed for the ambient conditions of temperature andhumidity;

5) all wetted parts of instruments sensors shall be non-corrosive and suitable for use with sewage;
6) all instrumentation systems for use out of doors shall be protected to IP 65;
7) all analogue displays shall be of the digital type with no moving parts utilising back lit liquid crystal diode LED technology;
8) instrumentation shall utilise solid state electronic technology and avoid the use where practical of any moving parts;
9) minimum maintenance requirement;
10) Instrumentation shall resume operation automatically on the application of power following a power failure.
11) All analytical instruments (if any)shall be single channel and have individual analyzer units.

Instrumentation systems shall be provided as detailed in the Employer's Requirements and as necessary for the efficient and safe operation of the Pumping Stations.

The Contractor shall provide systems to measure any other parameter required for the efficient and safe operation of the Pumping Stations.

Instrumentation sensors shall be suitable for the environment in which they are expected to work. Sensor located in hazardous (flammable) or potentially hazardous atmospheres shall be certified for use in these areas.

All Sensors shall be of self-cleaning type.

Instrumentation shall be selected and installed in accordance with the manufacturer's instructions. Wherever practical components of similar systems shall be interchangeable, i.e., open channel flume flow measuring systems and open sump or tank level measurement and pump control systems shall incorporate identical sensors and converter units. Instrumentation converter units shall where practical be located in the associated MCC common control panel well away from any injurious effects of the process.

Digital systems shall be provided as detailed in the Employer's Requirements and as necessary for the efficient and safe operation of the Pumping Stations.

The Contractor shall provide Pumping Stations to detect any other condition required for the efficient and safe operation of the works.

Levels in tanks shall be displayed as percentage full,

2.11.3 Flow Measurement and Control

The Contractor shall use electromagnetic flow meters, (Dia< 1000mm) andUltrsonic insertion type flow meters (Dia> 1000 mm) for all closed pipe liquid flow measurement as the standard flow meters under this contract. The flow meter system shall provide flow rate and totalized flow indication.

The pressure rating of the flow meter and flanges shall be equal to or greater than that of the pipeline within which it is installed. The preferred location for the flow meter converter/transmitter units is within a building. Where this is not possible, then the converter shall be installed in a suitable above ground enclosure providing the converter with suitable mechanical and environmental protection.

The flow signal converters/transmitters shall provide 4-20mA output linearly proportional to the rate of flow and shall provide a pulse output for flow totalizing. The flow meter electronic supervisory unit shall display the following on a minimum:

- Flow rate;
- Flow total-totalizer;
- High flow rate alarm;
- Low flow rate alarm.

Signals for the items above shall form inputs to the PLC and SCADA and be utilized within Operator displays. The integrator used for the second item above shall have at least six digits.

Each flow meter shall be provided with downstream and upstream isolation valve including the washout facility.
The preferred location for the flow meter converter/transmitter units is within the CWPS building. Where this is not possible due to the distance between the flow meter and the CWPS building, then the converter shall be installed in a suitable above ground enclosure providing the converter with suitable mechanical and environmental protection.

2.11.4 Ultrasonic Flow measuring system for Pipes

i. Ultrasonic Flow meters shall be provided on common discharge headers of each Pumping Station. Flow meter shall be of a multi-path, multi-beam type.

ii. Ultrasonic Transducers shall work on transit-time (time of flight) principle.

iii. The transducer probe shall be of the wet insertion type with facility for online insertion and retraction.The Contractor shall provide a section of pipe having uniform diameter, for installation of flow probes so as to configure a flow meter. The section of pipe shall be installed in the pipeline at site. The exact inside diameter of the pipe at the location of flow transducer shall be used for flow computation.

iv. Contractor shall construct a suitable concrete chamber for enclosing flow transducers to be mounted on underground pipe lines. A concrete enclosure shall be constructed above the chamber for housing the flow transmitter. For surface pipelines, a concrete cabin shall be constructed around the pipeline for housing the flow transducer and the flow transmitter. A lockable enclosure shall be provided for the flow transmitter cum computing unit.

v. In order to facilitate the removal / reinsertion of the flow transducers when the pipe-line is pressurized, the Contractor shall provide an insertion-retraction tool assembly which shall be leak proof at 1.5 times the working pressure. The same shall be made of anti-corrosive material.The online retraction tool shall be used during operation and maintenance period for any maintenance of the flowmeter without depressurisation of the pipeline. The online retraction tool shall be from the OEM only.

vi. The flow computer shall be microprocessor based and shall have diagnosis facilities.

vii. The Contractor shall ensure that the range of flows from one to six transmission pumps running can be adequately measured by the Flow meter system provided. The range of the Flow meter shall be adjustable.

2.11.5 Calibration

i. The ultrasonic flow meter shall be calibrated for the accuracy of velocity measurement wherein the velocities shall correspond to the flow range of the

flow meter covered in the tender.The calibration shall be carried out for the ultrasonic flow meter under test, consisting of multipath flow sensors, flow transmitter cum computation unit and flow indicator cum integrator unit.

ii. The calibration method shall be either gravimetric method or volumetric method. The 'test bed' shall be accredited by national /international certifying authority as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits – weighing method).

iii. The Contractor shall produce accreditation certificates for the test facility and the calibration certificate for the flow meter for review by Engineer and shall also demonstrate complete calibration on the test bed in the flow meter manufacturing facility where the meter has been manufactured during witnessing of the Factory Acceptance Test. The flow meter shall be acceptable if the accuracy and repeatability is equal to or better than those specified. The same shall be included in the QAP.

iv. Site calibration- Site calibration will be arranged and shown to prove the accuracy of actual flow

2.11.6 General Specification

i)	Service:	:	Flow measurement on common discharge header of each pumping station
ii)	Line size	:	As per process requirements
iii)	Range setting	:	As per process requirements and adjustable over full span and selectable.
iv)	Overall accuracy of measurement loop	:	±1.5% of full scale

2.11.7 Flow Sensor/Transducer

(i)	Type	:	Multipath, Insertion type (Clamp-on type not acceptable)
(ii)	No. of paths	:	Four paths (8 transducers)
(iii)	Measuring principle	:	Transit time
(iv)	Weather Protection Class	:	IP 68 of IS: 13947 Part (I)
(v)	Provision for online removal / insertion of flow sensors without	:	Required to be supplied along with each

	depressurisation of the line		flowmeter
(vi)	Accessories	:	Prefabricated integral cables for connecting sensors and transmitter Isolation valves

2.11.8 low Computer & Transmitter

(i)	Type	:	Multi-Channel indicating type having back-lit LCD display
(ii)	Input	:	From ultrasonic flow sensors
(iii)	Output	:	4-20 mA. DC (isolated)
(iv)	Zero and Span Adjustment	:	Required
(v)	Battery backup for totalized Flow	:	Required
(vi)	Facility to discard faulty sensor from averaging function		Required
(vii)	Facility to display flow measured by each path		Required

2.11.9 Flow Indicator and Integrator

(i)	Type	:	Electronic, Microprocessor based
(ii)	Display	:	Digital, seven segment back lit LCD display
(iii)	Digit Height	:	14 mm or Higher
(iv)	No. of Digits for		
	- Flow indicator	:	4 Digits
	- Flow integrator	:	6 Digits
(v)	Input	:	4-20 mA DC (Isolated) from flow transmitter
(vi)	Zero and span adjustment	:	Required
(vii)	Manual Reset Facility for flow integrator	:	Required (shall be key operated)
(viii)	Engineering Units for		

	- Flow rate indicator	:	CUM/Hr
	- Flow integrator	:	ML
(ix)	Battery backup for integrator	:	Required
(x)	Retransmitted output	:	4-20 mA Proportional to Flow rate

2.11.10 Electromagnetic Flow Meter

Full bore bi-directional electromagnetic flow meters shall be designed, manufactured and calibrated as per ISO/IEC 17025 standard. Meters shall also have actual Flow rate & Totalized value. The accuracy shall be +/- 0.5% of reading.

The sensors shall be as per ISO standard lengths (ISO 13359), so that inter-changeability can be carried out for the applicable flow meter sizes. The sensor shall also have built in grounding and empty pipe detection electrodes of SS316 for detecting partial flow condition & efficient operation purposes. The liner material shall be Polyurethane (PU). The sensor & transmitter shall be capable of working in tropical environment.

The sensors shall be rated IP 67. The transmitter shall be rated IP67 in line with local operating conditions. Installations shall be made with cables and /or conduits that guarantee the integrity of the system under all operational conditions. The transmitter/converter shall be wall-mounted type with a 2 line display for the indication of Actual Flow rate & Totalized value. A glass window within the protection enclosure with optical switches shall be provided for local reading purposes.

The enclosure material shall be non-corrosive and of die cast material. Magnetic flow meters shall be supplied with built in software feature to analyse and continuously monitor the health of the sensor, display errors in text format. Transmitter shall be capable of performing the verification program on demand or on request without taking meter off the line.
The transmitter shall be capable of being fully programmable. It shall have a set-up menu so that all relevant parameters may be user-set from the self-prompting driven menu.

The transmitter shall have totalizer units and shall have one (1) scalable pulse output & one (1) current i.e.4-20mA HART output. The current output shall be galvanically isolated. It shall be fitted with switched mode power supply capability 0-250V or 24 DC and 45-65Hz to cope with power transients without damage. The Totalizer value shall be protected by EEPROM during power outage, and utilizes an overflow counter.

The transmitter shall be having facility of indicating flow measurement. It shall be possible to separate the sensor and transmitters up to 200 meters without the need for signal boosters or amplifiers

Detailed technical specification of Full bore electromagnetic flow meter is as below.

General		
1	Application (Suitable for)	Treated Water
2	Op Temperature	0 to 50 Deg C Max
3	Op Pressure	Max 6 Bar g
4	Measurement	Instantaneous water flow Rate, Totalized Flow
Flow Sensor		
5	Type	In-Line Full Bore Electromagnetic flow meter.
6	Power supply type	Mains operated
7	Sizes (mm) /Qty	As per line size
8	Sensor Type	Pulsed DC
9	Process Connection	Flanged type
10	Weather Protection Class	IP68 as per IS 13947
11	Full Scale Velocity	0.2 to 3 m/s, vendor to provide the detailed sizing calculations based on the process details.
12	Electrodes	SS 316 L, Total 4 Electrodes system.

		Measuring electrodes – 2 Nos. Grounding electrode- 1 No. and Empty pipe detection electrode -1 No.
13	Coil Housing	Powder-coated die-cast aluminium Anti corrosive grade with IP 68 protection class with minimum 20 meter cable for remote mount transmitter connection
14	Flanges	Carbon Steel PN 10 as per EN 1092-1
15	Flow sensor Grounding	Grounding rings shall also be acceptable
16	Flow Tube material	SS304
17	Flow Tube Liner	Polyurethane
Flow Transmitter Unit		
1	Type	Microprocessor based with facility to configure the range
2	Type of Display	2 -Line LCD display with operation keys (touch control)
3	Transmitter Type	Remote Wall Mounted with 5 cable glands, integrated fixing points for wall mounting, with sensor interface
4	Units for Display	Flow Rate m3/Hr, Totalized Flow ML
5	Input	From Flow Tube
6	Accuracy	+/- 0.5 % of Measured Value
7	Operation	Via local display, Via HART handheld terminal
8	Output proportional to Flow rate	Current output (4–20 mA HART); pulse/frequency/switch output (2); status input
9	Power supply	0-250 VAC, 45-65Hz – Optional - 11 to 40 V DC
10	Self-diagnostic feature	Following minimum diagnostic features shall be provided Empty pipe detection,

		system diagnostic features
11	Transmitter enclosure material	Non-corrosive, Die Cast Aluminium
12	Communication	Suitable for Wired communication with control system and HART based integrated and service interface
13	Memory	100% secure data storage
14	Weather Protection Class	IP 67 (NEMA 4X) for flow transmitter
14	Calibration Method	Gravimetric Method ISO 4185 / volumetric method (ISO 8316). All test equipment fully traceable to national and international standards with 5 point calibration.
15	Flow calibration rig	Duly Accredited according to ISO/IEC 17025

Note-1:The flow meter manufacturer/supplier shall have full ISO 9000 series accreditation and fully traceable calibration methods. The suppliers shall also have a testing facility in India so that methodology and procedures can be verified. Each meter shall be wet calibrated with 5 point calibration to verify performance in accordance with the specification & submit report for the same. The testing facility shall be duly accredited in accordance with ISO/IEC 17025 standards.

In the event if the meter manufacturer does not have a testing facility in India, the flow meter shall be tested & inspected before shipping at the Manufacturers factory works, where the meter has been manufactured.

Note-2: The flow meter manufacturer shall have local offices in India and full service capability in the major cities (metro’s) throughout the country. Full contact details for key personnel, shall be furnished on request. The supplier shall provide evidence of at least five years involvement in the manufacturing of meters worldwide.

Note-3: The flow meter manufacturer shall provide full data on each meter required, including optimizing and sizing programs calculation sheet.

2.11.11Temperature Scanners

Temperature scanner shall be provided to detect high temperature on motor and pump in order to generate tripping signals. The input signals to temperature scanner shall be derived from industrial type Pt-100 resistance temperature detectors provided in the motor windings, the Pump bearings, the Pump Casing and the motor bearings.

Note: The same shall be provide as part of pump performance monitoring system.

(a) General

(i)	Service	:	Pump and Motor winding/bearing/ casing temperature measurements
(ii)	Quantity	:	As per process requirements
(iii)	Range	:	As per process requirements

1	Service	Motor winding and bearing and pump bearing temperature measurements for each pump motor in the raw water and clear water pumping stations
2	Range	0 to 2000 C
3	Type	Microprocessor based
4	Mounting	On Instrument Control Panel (ICP) of respective pumping station
5	Accuracy	0.2% of range
6	Resolution	0.1o C
7	Input Signal	From RTDs for each pump motor
8	Display	LCD / LED display, 4 digit for data and 2 digit for channel No.
9	Scanning rate	Selectable
10	Communication port for interfacing with PLC system	RS-485 (With Modbus protocol)
11	Set point	2 set points (high and very high) for group of channels. Minimum 3 groups of channels shall be provided. Separate relay required for each set point.
12	Type of contacts	2 change over contacts for each set point
13	No. of channels	12 Nos minimum. (6 Nos. for pump winding

		temperatures, 2 Nos. for motor bearing temperatures, 2 Nos. for pump bearing temperatures and 2 Nos. spare).
14	Programming	Through keyboard mounted on the front facia
15	Password facility	Required

2.11.12 Level Measurement and Control

The following section describes the minimum technical specifications for level measurement and control under this contract. Ultrasonic level type measurement devices shall be used incorporating integral temperature compensation

Where foaming problems are identified as a local concern, the level measurement by level transducer shall be considered. Float switches are reserved as backup to the level indicating transmitters.

Sensing heads shall be mounted on 316 stainless steel brackets and positioned to ensure an unhindered beam path and ease of access for maintenance.

2.11.12.1 Ultrasonic Level transmitter:

	Transmitter	
1	Type	Ultrasonic
2	Principle	Pulse Time of flight
3	Output	4-20 mA HART current
4	Housing	Die Cast Aluminum
5	Electromagnetic compatibility	Interference emission to EN 61326; Equipment class B Interference immunity to EN 61326; Appendix A (Industrial)
6	Ingress Protection	IP67
7	Accuracy	+/- 2 mm or 4 mm depending on selection or 0.2% of set measuring distance Whichever is greater.
8	Area Classification	Non-Hazardous/Hazardous as applicable
9	Temperature range	-40°C ... +80°C

10	Display	4 line LCD display. Menu guided operation Display of Envelope curve.
11	Configuration	Using Keypad on display
	Sensor	
12	Range	Liquids 0 to 5m and 0 -10m depending on Tank size
13	Temperature range	-40°C ... +80°C
14	Max Pressure	3 bar abs
15	Materials	Sensor: PVDF Seal: EPDM
16	Process connection	Threaded or universal flange dependent on model selection
17	Degree of protection	IP68

2.11.12.2 Float Switches

1) Level switches of the buoyancy type shall consist of a non-mercury switch with changeover action enclosed in a non-corrodible material. A balance weight shall also be incorporated in the switch to counteract the buoyancy effect of the specific gravity of the particular fluid. The connecting cable shall be factory sealed to the switch. The switches shall be installed in a stiller tube in the wells.
2) Level switches shall be installed with a minimum of 3 m of spare connecting cable neatly coiled at a supporting bracket. The connecting cable fixing shall facilitate any alteration in operating level within the limit of the spare cable.
3) The level switches shall act as backup to the level transmitter in the control interlock sequence.

2.11.12.3 Level Gauge (Float & Tape)

Type	:	Float and Tape
Float & Tape MOC	:	AISI 316
Pulley Housing	:	Aluminum
Guide wire	:	SS 316 Stainless steel
Accuracy	:	+/- 2 mm
Indication	:	On circular or vertical dial
Rating	:	Twice the design pressure.

2.11.12.4 Capacitance type level measuring system

(i) **Level Transmitter**

a.	Service	:	Surge vessel level measurement
b.	Quantity & Range	:	As per process requirements
c.	Mounting	:	From top of stand pipe
d.	Zero span adjustment	:	Required
e.	Accuracy of measuring loop	:	± 1% of full scale
f.	Output signal	:	4-20 mA

2.11.12.5 Conductivity type level switches

(i) **General**

a.	Service :	Clear water reservoirs, Surge vessel, and surge tank level detection
b.	Quantity & Range :	As per process requirements

(ii) **Conductivity Probes**

a.	a.	No. of electrodes	:	As per application
	b.	Probe insulation	:	Teflon
	c.	Mounting	:	Flanged (From top)
	d.	Probe head housing material	:	Aluminium
	e.	Spacers between electrodes	:	Required
	f.	Stilling pipe	:	Perforated PVC/HDPE pipe

(iii) **Level Controller**

Input : From conductivity probe

a. Switch : (for each setting)		contact	2 No. + 2 NC
b. Contact :		rating	24 V DC, 2A
c. Sensitivity control	:		Required Field
Mounting			IP-65 of IS 13947 Part 1
Protection class			

2.11.13 Pressure Instrumentation

2.11.13.1 Pressure Gauges, Switches & Indicating Transmitters:

1) Pressure gauges shall comply with BS EN 837- Parts 1, 2 and 3. Pressure Gauges, Switches & Indicating Transmitters shall have over range protection up to 1.5 times the maximum anticipated line pressure.

2) Internal parts shall be of stainless steel, bronze or other corrosion resistant material.

3) All Pressure Gauges, Switches & Indicating Transmitters shall be supplied complete with isolating valves and calibration points to enable calibration or removal without loss of fluid.

4) Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitably adjusted and the amount of compensation marked upon the dial.

5) Pressure and differential pressure switches shall have contacts with separate ‘cut in’ and ‘cut out’ pressure values.

6) The nominal pressure values at which pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value(s) shall be clearly indicated by means of a scale and pointer.

7) Pressure monitoring shall be by a sensor suitable for the medium and pressure/level range.

8) The sensor shall be selected to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. The sensor shall be suitable for either free wire suspension in the medium or fitted remotely and provided with threaded sockets to permit connection of pressure pipe work.

9) A transmitter shall be provided either integral with the transducer or separately mounted and converting the signals received from the transducer to a 4 to 20 mA signal proportional to the range specified.

10) The transmitter shall have provision for span and zero adjustment.

2.11.13.2 Specifications for Pressure Transmitters:

Pressure measuring system shall consist of pressure transmitter and digital pressure indicator and any other items required to complete the pressure measuring system. Pressure transmitter shall be rugged in construction and shall be suitable for continuous operation. Pressure transmitters shall be designed for operation over 130% of full range. It shall have EEPROM for storing of history data.

Pressure transmitter shall be suitable for field mounting. They shall provide 4-20 mA Current output proportional to pressure. Transmitter output shall be isolated and shall be suitable for transmitting over long distance. Pressure transmitters shall have high degree of weatherproof protection as specified in technical particular. Pressure transmitters shall have LCD display to indicate pressure.

The Contractor shall mark the exact location of pressure measuring point on the pipe line. The contractor shall provide all the hardware items including manifolds, nuts, bolts, pipes, valves, gaskets etc. required for the work.

Sr.No.	Detailed specifications for Pressure Transmitters	
1	Specifications	Pressure Range 0 to 10 /20/50/ 100 Kg/cm2 g
2	Process Temperature range	-20 to +125 deg.C.
3	Output Signal	4 to 20 mA with superimposed digital

Sr.No.	Detailed specifications for Pressure Transmitters	
		communication protocol HART 6.0, 2-wire
4	Signal range –	4 to 20 mA HART 3.8 to 20.5 mA
5	Signal on alarm	As per NAMUR NE 43 • 4 to 20 mA HART
6	Resolution	Current output: 1 micro Amp
7	Response time	<250 ms
8	Damping	required
9	Supply voltage	11.5 to 45 V DC
10	Reference accuracy	± 0.1%
11	Housing	Die Cast Alu. Housing
12	Diaphragm Material	Ceramic
13	Long Term Stability	± 0.25% URL/year
14	Turn Down	10 : 1

2.12 Submissions to be made by the contractor during the contract period:

1) The Contractor shall make submissions to the Employer Representative of all design drawings, schedules and complete documentation on spare parts relating to instrumentation and control equipment and systems provided under this Contract.

2) These submissions shall includethe following:
   - Functional design specification (FDS) The Contractor shall submit a complete functional Design specification (FDS) for approval by the Employer Representative within three (3) months of the award of the Contract. The Contractor should take note of the importance of this clause.
   - The functional design specification shall be submitted for the following:

A. Instrumentation

a) Instrument schedule with process ranges and instrument range, and instrument model numbers

b) The FDS shall include on a minimum, Instrument location layouts, Instrument datasheet, OEM product brochure, Instrument hook up diagrams and quality Assurance plan for inspection at manufacturer's test and quality facility where the equipment has been manufactured, as required under bid requirements.

c) General arrangement drawings of field-mounted instruments showing installation details.

d) General arrangement drawings of instrument and control panels, full dimensions in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.

e) Layout drawings of panel fascias showing instruments, controls and details of all labels.

f) Internal circuit and wiring diagrams for instrument and control panels.

g) Schematic control diagrams.

h) Instrument loop diagrams.

i) Instrument wiring and piping diagrams.

j) Interconnection wiring diagrams.

k) Cable block diagrams, drawings and schedules.

l) Instrument system and panel power distribution diagrams.

m) The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.

n) The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate.

o) Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

B. IOT Based IPMS & associated Control & Automation

1) This document shall serve as the primary mechanism by which the Employer Representative may confirm that the Contractor possesses an accurate understanding of the system and its control requirements.

a)On a minimum, FDS shall comprise an overall description of the plant, its functioning and control, and a detailed description of each section of the control system covering modes of operation, manual overrides, set-point and parameter selection and adjustment. The detailed description shall include a step-by-step control description which defines the function of each piece of equipment and each control action and interlock, including details of the program in each programmable item. Flow charts shall be used to depict the control philosophy along with the write up for the same.

b)Proposed System Architecture, SCADA screens, set point schedules, shall be an integral part of the FDS submissions.

c)The FDS shall describe the 'fail-safe' features incorporated into the design for the event of failure of a plant item or system, or loss of an input signal.

d)The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.

e)The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate.

2) Drawings and schedules as part of FDS (For both Instrumentation & Control & Automation):

a)Process and instrumentation diagram (P&ID) shall be as per ISA 5.1 latest release. The P&ID shall contain the following on a minimum and in sequence:

b)Legend sheet inclusive of process line abbreviations, line designation, process designation, symbols of all equipment and general notes.

c)Tag Identification system. (The tagging philosophy shall be submitted before the submission of the P&ID for review and approval before the tagging is incorporated in the P&ID).

3) Typical Signal interface sheet
   1) Process & Instrumentation sheets as per each process, which shall depict the interlock sequence for each equipment & process operation. The interlock sequence shall be depicted by using interlock numbering next to the equipment/process.
4) Contractor shall coordinate the process control philosophy and P&ID before submission.
   a) General arrangement drawings of field-mounted instruments showing installation details.

   b) General arrangement drawings of instrument and control panels, fully dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.

   c) Layout drawings of panel fascia showing instruments, controls and details of all labels.

   d) Layout drawings of panel interior showing equipment, terminal blocks and cable ways.

   e) Annunciator arrangement and engraving details.

   f) Internal circuit and wiring diagrams for instrument and control panels.

   g) Schematic control diagrams.

   h) Instrument loop diagrams.

   i) Instrument wiring and piping diagrams.

   j) Interconnection wiring diagrams.

k) Cable block diagrams, drawings and schedules.

l) Instrument system and panel power distribution diagrams.

m) Programmable-device functional design specifications which shall include hardware details, logic flow charts, panel GA, panel wiring diagrams, ladder diagrams and program listings.

n) Schedules of inputs to and outputs from programmable controllers and telemetry outstations.

o) Labelling & tag schedules.

p) Communication details (data transfer between pumping stations), interface & integration between IOT based SCADA system at each pumping station and FOC network to be established under separate contract by a different contractor.

q) Data communication (interface & integration) between pumping stations and WTP control system.

r) Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

5) All other drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels and the like and for the complete understanding of the operation, maintenance and extension of the system including any required for the Purchaser to dismantle, repair, maintain, modify or extend the Plant.
6) Control room, RIO Room interior design layouts, interior design diagrams, control room wiring layout, access control point diagrams, to house the IOT based IPMS system, LED video wall, FOC panels, integration panels, etc.
7) Data and calculations
    a) Manufacturers' catalogues and data sheets.
    b) Calculations to support control system design.
    c) Specification for protective coatings and painting.
8) Certificates
    i. Manufacturers' works tests.
    ii. Pre-installation checks.

iii. Pressure-testing schedules.
iv. Instrument loop test check sheets.
v. Installed instrument performance tests.
vi. System tests.
vii. Statutory certificates of compliance (such as hazardous area equipment).

Note: The Contractor shall submit and obtain approval of the FDS from the Employer Representative before beginning procurement. The contractor should take note of the importance of this obligation.

The contractor shall submit the Main Deliverable List (MDL) covering all the submissions & tentative schedule for the same at the beginning of the project.

2.13 FUNCTIONAL REQUIRMENTS -Integrated Pump Performance Management System

Considering the Stage IV Phase I Pumping stations of the 3 locations, TK Halli, Harohalli and Tataguni, Integrate Pump Performance Management Solution (IPMS) is expected to monitor the pumping station as a whole and report its performance at various levels. The solution is expected to measure the following parameters as a minimum. Below is the high-level function diagram of the pumping station and the parameters that should be measured and reported. While the reservoir will remain 1 (with a partition), rest of the assets of like pump, Motor, main lines, does not differ from pumping station to pumping station. Refer to Pump Station Details to understand the size and scale of each of the Pumping station.

The solution is also expected to provide Human Resource Management (HRM) capabilities like attendance tracking, shift details of people in the Pumping station and availability of people for a specific activity. Along with Human Resource management, the solution will also provide inventory management details. This will help each of the Pumping stations for effective stock keeping of spares / equipment. Assets will be mastered within this solution at least at 2 levels of hierarchy and stock keeping or inventory management will be a part of the exercise to ensure adequate levels of critical inventory is maintained to avoid any disruption to the service.

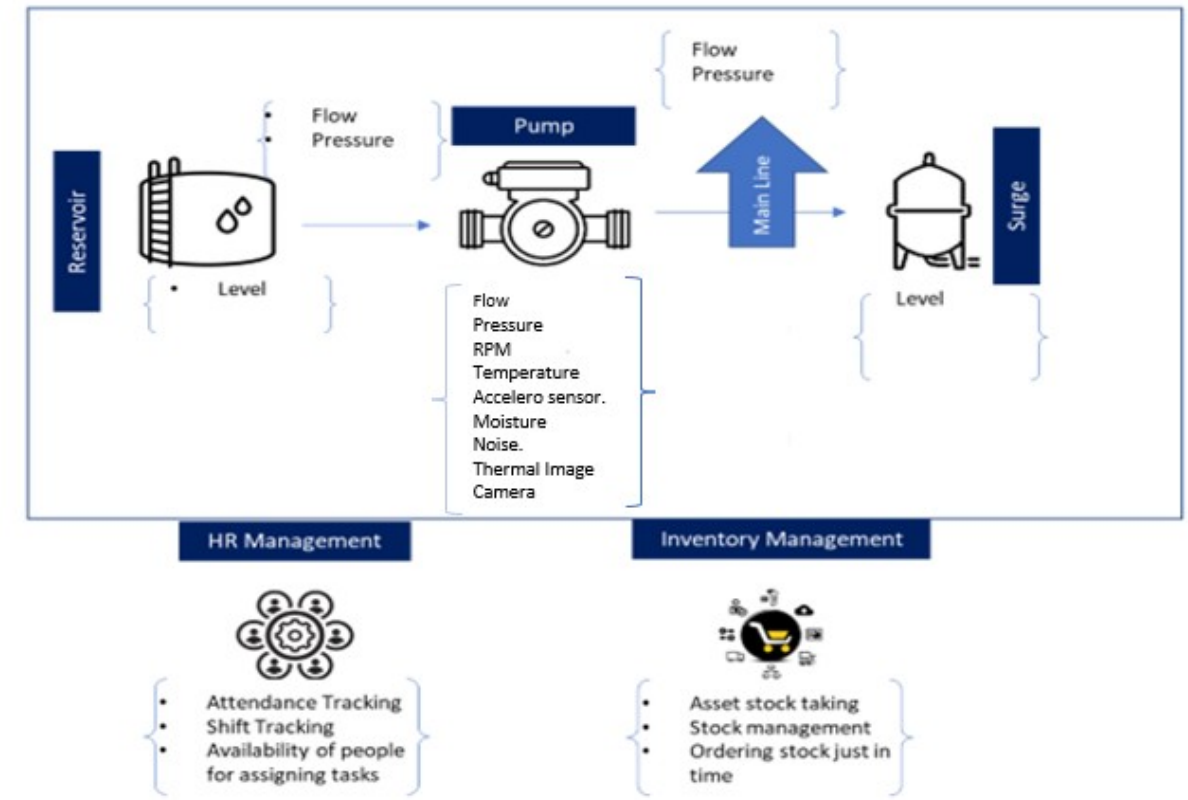

Figure 1: Function diagram of a Pumping station

2.13.1 Integrated Pump Performance Management Solution (IPMS)

The IPMS shall be hybrid web and mobile based solution having combination of

a) Enhanced performance monitoring supported by high precision AI enabled IIOT Sensors with data acquisition arrangement. This will help the BWSSB in maintaining and managing the critical network infrastructure of BWSSB in an optimal way and enhance the services provided by the BWSSB. The sensors required for monitoring the Pumping stations are expected to be of industrial standard and provide precision output to the solution that is being provided.

b) Advanced analytics platforms, using Digital Twins & deep learning based Artificial Intelligence. The solution should be capable of automated linking of the Pumping station operating parameters to the dynamic performance of motor and pump with condition monitoring and fault diagnostics, to provide a holistic view of the performance of each pump set and the pumping station. The goal is to provide meaningful insightful interlinked information that can lead to actionable outcomes for continuous improvements.

c) Local monitoring is the key as the Pumping station is manned continuously. Therefore, it is required to provide local intelligence to the team on the ground who act as the first resolution provider. This should be provided on the mobile and on the screen that will be installed in the Pumping Station.

d) While local monitoring is critical, remote monitoring of all the Pumping Station is vital for knowing the birds eye view of performance of each of the Pumping Station.

The technology offered by bidders should be an integrated solution that will link all the operating parameters and the machine/ system data to the performance and condition of the machines, such that the entire data generated by the system is linked and verified.

e) Digital Twin :

i. Digital twin: Digital representation of the Pump, motor (1:1 simulated model).
ii. During predictive maintenance particular part of the pump/motor should be popped in 3 D image.
iii. Deep learning or machine learning based AI for predictive maintenance.

f) Edge Hardware :

Device should fetch data from sensor, should trans-receive the data between cloud and edge. It should have local memory to store real time data when internet is not available. Further it should also process the data as a client server.

2.13.2 Functional Compliance Sheet (To be filled by the bidder)

Sl. No	Requirement	Yes/No	Deviation Statement
1	Web application that can run in isolation at each of the Pumping Station without any need of internet. (i.e. Performance of Each pump should be displayed in in front of each pump with a Kiosk display by communicating to the local server/edge device with in the same network mask)		
2	Following parameters can be captured and		

	reported in the form of performance management at Reservoir level, pump and motor and at Pumping main and surge levels a. Pressure b. Water Temperature c. Pump Temperature DE & NDE d. Flow e. Vibration f. Motor Temperature DE & NDE g. Winding Temperature h. Pump and Motor body temperature i. RPM j. Level in Reservoir k. Energy/power l. Noise level m. Moisture level in grease/oil		
3	Thresholds can be set for each of the parameter and at each of the Pumping Station independently		
4	Pumping Station can be geographically located on the map. Real time information about the parameters, namely a. Efficiency (Thermodynamic) b. Efficiency (Energy and water nexus) c. Flow. (Thermodynamic) d. Flow ((Energy and water nexus) e. Water level. f. Head. (Thermodynamic) g. Head (Energy and water nexus) h. Power consumption of each pumping set. (Thermodynamic) i. Power consumption of each pumping set. (Energy and water nexus) j. RPM. k. Vibration. l. Temperature. m. Pressure.		

	n. Water Level in reservoir. o. Moisture content if any in oil/grease on hourly, daily, weekly monthly report on supply and demand. p. Predictive maintenance q. Auto, manual with local and remote alarms.		
5	Red, amber, green reports available for each of the pump, each of the Pumping Station as mentioned in Pumping Station Details.		
6	Role based authentication is available for the web based and mobile based application – meaning, BWSSB can restrict access of data and therefore the reports depending on the individual's role.		
7	Reports are downloadable in excel or pdf format between two time and date range		
8	Alerts and thresholds that are set can be triggered over e-mail		
9	Alerts and thresholds that are set can be triggered over SMS		
10	Alerts and thresholds that are set can be triggered over WhatsApp		
11	Escalation management: If the alert of notification is not resolved within a stipulated time to the individual it is assigned, then the solution should have a provision to set the escalation matrix for each of the Pumping Station so that the alter and notifications are sent to the next level		
12	SLA management, considering that there are O&M contractor working in the Pumping station, there should be a provision to configure SLAs and assign them to the notification and alerts for response and resolution. Failing to resolve such issues		

	within agreed SLA should result in penalty calculation and assigning to the O&M contractor.		
13	Mobile app should be available to monitor the status of the Pumping station and access should be controlled using RBAC		
14	Push notification options to be available on the mobile application for alerts notification		
15	Adding a new pump in a Pumping Station should be configurable and should not lead to any code changes		
16	Adding newer parameters for monitoring should configurable and should not lead to any code changes		
17	• Real time 2D/3D graphs along with its values for each parameter of the sensors and associated parameters with dynamically varying boundary conditions. • Efficiency (Pump), • Electric power quality, • Vibration, • Energy Consumption, • Pump Efficiency and • Pressure at various points, • Supply and demand. • BEP curves.		
18	Preventive maintenance for all the equipment including sensors. Provision to timely schedule the task for maintenance for all the equipment mentioned in Pumping Station Details and Instrumentation Details - Sensors		
19	Computation of real time Pump Efficiency calculation by thermodynamic technique.		
20	Prognostic and diagnostic of pumping station for pump and motor		

21	Efficiency calculation through flow and energy water nexus		
22	Power factor computation.		
23	Predictive maintenance: To reduce the overall life cycle cost associated with the Pumping station.		
24	Real time water performance, optimization and management including but not limited to • Optimization of Cloud platform for real time analytics, • Analyse the historical pattern through Statistical and deep learning enabled AI tools.		
25	Workflow management: The system should provide “My Activities View”- view role-based activities and standard operating procedures as a gateway to handling incidents and work orders. Should integrate with an enterprise asset management.		
26	Security: Multilayer based security for hardware, IIOT devices, gateway, cloud and other devices and application.		
27	Data integration and storage: Secured private, public and local storage		
28	Touch panel-based control and monitoring at each Pumping station (Industrial Grade)		
29	Auto display of various pump, motor and power parameters		
30	Integrated Pump Performance management system is expected to provide Human resource management to track the following a) Attendance of the employees at Pumping stations b) Availability of the employees along with their skills to ensure right set of work is assigned to them c) Shift management information		

31	Integrated pump performance management system is expected to provide asset and inventory management capabilities with the following features a) Asset stock keeping b) Asset stock ordering c) Mastering asset of each of the Pumping stations.		

Figure 2: Functional Requirements Compliance Sheet

2.13.3 Non-functional requirements Compliance Sheet (To be filled by the bidder)

Sl. No	Requirements	Yes/No	Deviation Statement
1	Web application performance Login page to be available in less than 15 seconds		
2	Once the credentials are provided, home page to be available in less than 15 seconds		
3	All reports to be loaded in minimum 15 and max 45 seconds as far the date range is set to 2 months of data. i.e. Reports of Pump, Station, Motor, combined efficiency, alerts and alarms, discharge, power consumption, inventory of spare parts, HRM etc.		
4	Data archival option to be available		
5	Load testing for 20 users with data size of 6 months per Pumping station without impacting the performance criteria		
7	All downloadable reports to be downloaded in less than 45 seconds for a maximum duration of 6 months' time		
8	Any changes in the solution ex-adding a pump, deleting a pump (CRUD operations)		

	should have sufficient audit trail		
9	Solution should successfully pass penetration testing and should be certified by the external vendor		
10	If the system is integrating with any of the external system, this should happen either via API calls or using the enterprise integration bus. No FTP/SFTP should be possible		
11	Adequate interfacing acknowledgement should be available at network layer and at application and database layer		

Figure 3: Non-functional requirements compliance sheet

2.14 Technical Specifications of IPMS

The IPMS shall be hybrid web based having combination of (a) basic Metering supported by high precision AI enabled IIOT Sensors with data acquisition arrangement and (b) advanced analytics platforms, using Digital Twins & deep learning based Artificial Intelligence. The solution should be capable of automated linking of the all the pumping stations operating parameters to the dynamic performance of machines & systems with condition monitoring and fault diagnostics, to provide a holistic view of the performance of each pumping station. The goal is to provide meaningful insightful interlinked information that can lead to actionable outcomes for continuous improvements.

The independent simulations based on energy, pressure, and other pumping station parameter data should be continuously compared to identify the energy requirement against the actual energy use against each set of data logged. The energy mismatch thus identified and quantified should provide insights into the development of prognostic and diagnostic in real-time.

The technology offered should be an integrated solution that will link all the operating parameters and the machine/ system data to the performance and condition of the machines, such that the entire data generated by the system is linked and verified.

Data integration and storage: Data should be stored preferably in BWSSB server or NIC. Or else any other within India.Data shall be stored in cloud is up to 2 years.

The IPMS should be capable of the providing following real time information and actions and activities (GIS Map to be changed and pump Station name);

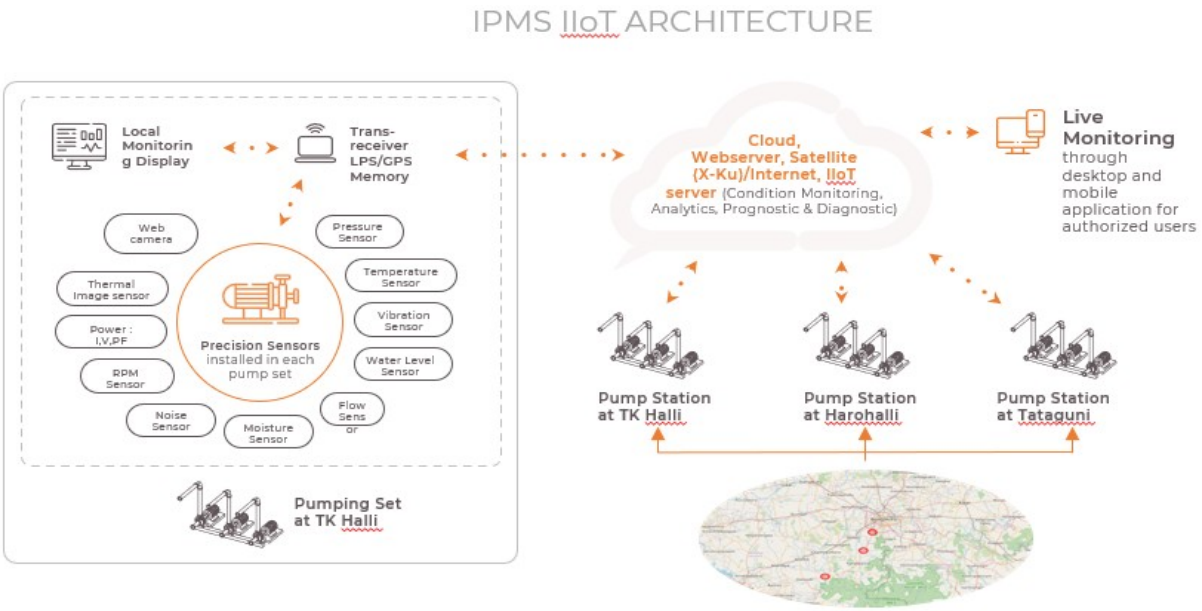

Figure 4 : High-level technical architecture

A. Operating performance

i. Number of Pumps operating.
ii. Hours of run Pump wise.
iii. Hour of run of the pumping station with combination of pumps.
iv. Discharge Pump wise.
v. Total discharge of Pumping Station.
vi. Static Suction Head.
vii. Friction Loss in Suction piping.
viii. Static Delivery head.
ix. Friction Loss in Delivery piping system.
x. Total Head of Pumping system.
xi. Water levels of pump suction Intake well/ Pumping Station.
xii. Pressure in Common manifold.
xiii. Flow rate in the common manifold.
xiv. Efficiency of Each pump.

xv. Combined Efficiency of the Pumping Station.
xvi. Overall efficiency of the System.
xvii. Online comparison of performance of pumping station located in three different locations.
xviii. Online comparison of the pump parameter: actual visa vis committed performance like discharge, head, power consumption and efficiency.

B. Site Parameters

i. Online power availability/ power failures.
ii. Input voltage.
iii. Current, frequency.
iv. Power factor.
v. Power consumption Pump wise.
vi. Power consumption of Pumping Station.
vii. Bearing Temperature ℃ (max-min, average) Pump (DE &NDE).
viii. Bearing Temperature ℃ (max-min, average) Motor (DE &NDE).
ix. Pump Vibration mm/sec (max-min, average).
x. Motor Vibration mm/sec (max-min, average).
xi. Speed (RPM).
xii. Total hours of power failure.

C. Type of alerts

i. Temperature alerts for Motor windings
ii. Temperature alerts for Pump (Drive end and non-Drive end)
iii. Temperature alerts for Motor (Drive end and non-Drive end)
iv. Pressure Transducer for Delivery side and pumping main.
v. Vibration / Accelerometer alerts for Motor
vi. Vibration / Accelerometer alerts for Pump
vii. Total Flow and Flow rate alerts
viii. Noise alerts
ix. RPM alerts
x. Reservoir Level alerts.
xi. Moisture content in oil/grease alerts
xii. Pump and Motor body temperature alerts.
xiii. Power quality alerts.
xiv. Power consumption alerts.

2.14.1 Interconnected pumping station alerts

These alerts are expected to capture the performance of downstream Pumping station and communicate to the upstream Pumping stations.

Table 1: Interconnected alerts

Downstream Pumping station	Upstream Pumping station
None	TK Halli
TK Halli	Harohalli
Harohalli	Tataguni

TK Halli being the first Pumping station, there is no downstream Pumping station, however, for Harohalli pumping station , TK Halli pumping station will act as downstream Pumping station and Harohalli pumping station will act as downstream Pumping station for Tataguni pumping station.

Type of alerts for interconnected pumpstation management;

i. Downstream pressure in case there is a low pressure
ii. Downstream level in case the level goes below a certain level
iii. Power disruption at downstream pumpstations

2.14.2 Commercial information and calculations

i. Cost of energy per Cubic meter to take in account fixed charges and energy charges = average in year, on daily, monthly yearly basis and comparison with various other pumping station.
ii. Penalty for achieving below committed efficiency resulting higher power consumption. On month-to-month basis, annual basis and cumulative for the specified period.
iii. Penalty for not achieving desired power factor at pre decided rate.
iv. Calculating the liquidated damages at pre-defined formula for various defaults by the O & M contractor.

2.14.3 Repairs and Maintenance

i. Details of alarms with time tag; with escalation protocol by email and if possible, by SMS.
ii. Capture Details the timing when the abnormality attended and the person concern.
iii. Calculate the Penalty for delay in attending /rectifying the defects/abnormality.

iv. Record Spares and consumables inventory, date in /out, cost, alert if inventory below minimum level.
v. Record Total no of non-operative Pumping set with period of non-operation.
vi. Record Reason for non-operation of Pumping set.

2.14.4 Basic Reporting

i. Report of Abnormality in machine behaviour.
ii. Exploring Dynamic saving opportunities by regularly optimizing Pumping Operations through machine sequencing based on demand, water level etc.
iii. Maintain Automated Electronic Logbooks.
iv. Monitoring, Analysis and submit online the daily, weekly, and monthly MIS in prescribed format.
v. Monthly Energy, Water and Asset Performance Assessment, Audit &Review and submission of online monthly reports.

2.14.5 Additional Information

i. Storage in local server of web camera input for one month.
ii. Real time Consolidation of performance of pumping station.

2.14.6 Consolidation of Pumping stations information at,

i. Each pumping station Level.
ii. Assistant Engineer Level.
iii. Assistant Executive Engineer Level.
iv. Executive Engineer Level.
v. Superintending Engineer Level.
vi. Chief Engineer Level.
vii. Chairman Level.

Reliability, stability, efficiency and quality of Pump performance monitoring system product and solution is primarily depending on how pure, high precise resolution say 24-bit resolution Analog to digital converter (ADC), undamped signal and data with right time stamp from state-of-the-art sensor received by edge device. Therefore, the vendor selection will be considering the following;

i. Single bidder who provides end to end product and solution, viz. Sensors to hardware to hybrid cloud, IPMS and product installation and training for the entire contract period.

ii. Customizable and reconfigurable 24 bit Analog to Digital Converter with clock speed 200MHz.

iii. Bidder should have in house product design R &D centre, lab testing facility.

iv. Simultaneously data should be transmitted to Cloud and SCADA (optional).

v. Hybrid Cloud application platform should work on any platform (Microsoft – windows or Linux OS).

vi. Digital twin, analytics, Deep learning based Artificial intelligence enabled condition monitoring,

vii. Android and iOS(Apple) platform independent mobile application with profile and level based access rights.

2.14.7 Cyber Security

i. Web applications: should follow Open Web Application Security Project (OWASP) standard to protect from cyber attacks.

ii. Gateway/Edge devices:

a) Operating system: Windows IoT / Linux embedded or other;

b) with operating system recommended licensed fire wall (defender) protection system.

iii. Managed switch with firewalls: Firewalls at Managed switch, Edge/Gateway and Internet service provider.

iv. Cloud Service: Government approved Cloud server based in India or Government of India servers (NIC).

2.15 Condition Monitoring of Pumping Set

1) The fundamental need to be addressed in condition monitoring of machines is to track and report abnormal machine behaviour as well as provide an early warning system to avert catastrophic machine failures. The condition monitoring solution shall be seamlessly integrated into the performance monitoring and plant operational data to have a holistic picture. The integrated solutions should only be preferred, to ensure better data correlation to identify the root cause of the abnormality.

2) The combination of both direct and indirect measurement methodologies will be used for condition monitoring. The key consideration is that the solution offered should differentiate a normal and abnormal behaviour of the machines (Motor and Pump), other than the variation in efficiency according to the operating conditions.

3) In the case of conventional solutions with direct measurement of vibration and temperature sensing, the vibration sensors shall be used for the motor as well as the pump. The temperature sensing is as per the provisions available for the machines. The sensor data captured will be integrated to make a meaningful interpretation of the abnormality levels duly calibrated and indexed to understand the degree of abnormality and the probable faults.
4) In the indirect method of condition monitoring using dynamic performance modelling of machines against real-time plant operational data, the dynamic energy requirement duly simulated will be compared with the actual energy use against each data log. The system should be sensitive enough to detect even a few watts of extra energy absorption by the machines or a reduction in energy absorbed due to the reduced outputs from the tested and calibrated conditions of the machines. The energy mismatch thus computed will represent the energy feeding the fault and deteriorations. A library of probable errors will also be made based on the energy mismatch.
5) The IPMS fault detections will also include the abnormal behaviour and calibration error of the instruments deployed. The best-in-class instruments should be recalibrated to specified accuracy levels through an approved testing agency on a yearly basis and should be upgraded from time to time. The solution will record through the web-based browser or mobile application, the abnormality development and fault identification and the breakdown and repair history. This data along with the plant operational data should provide a big data platform for advanced fault diagnostics and continuous learning and improvement.
6) The condition monitoring solution will trigger the alarm on the dashboard and send the automated SMS based on the severity of the abnormality in a configurable order of reporting sequence at various levels of administration. Care will be taken to minimize the false alarm conditions, while improving the accuracy and reliability of the condition monitoring through continuous refinement of the alarm settings on the threshold values of the fault tolerance. The alarm duly accepted by the concerned personnel shall be suppressed with the report status changed as" Under investigation". The entire reporting process is through designated mobile phone numbers duly configured, recording the names or identity of the respondents for each incident.
7) Sensors data fetching : Sensors should send data at least per second to the edge device, however if there is any communication issue, data should be sent every minute to the cloud.

2.16 Performance Monitoring

1) The performance monitoring and audit should be an on-going function leading to continuous performance optimization. Board will establish a centralized pump monitoring centre for performance and condition monitoring and analysing the performance all pumping station(s) in the place designated by the Board. The centralized monitoring station should also provide remote monitoring and analysis for efficient management of the pumping stations. The O & M contractor of that particular pumping station and or Board will be able to avail this facility from the remote monitoring centre located at a different geography.
2) The metering monitoring analysis and audit should be the integrated function directly linked to the measurement and verification process with seamless integration of the data.
3) There should be a review of Energy, Water & Asset Performance on a continuous basis and a brief report to be submitted along with the information required by the Board as per the schedule defined by the Board during the Contact period. This report is to be prepared based on the data and analytics and will contain the important incidents reported for each pumping station during the month. The audit report should contain the recommended actions to be initiated by the O&M Staff / Contractor of that particular pumping stations on a monthly basis that includes urgent maintenance, retrofit, replacements or further investigations. All critical information should be passed on to the respective operating team / administration levels of Board and designated departments on a real time or near real time basis by software. The exact reporting structure should be evolved from the existing reporting format of Board with the additional requirements as envisaged in the tender document for Integrated Pump Performance Management Solution (IPMS). The frequency of reporting and review meetings shall be decided mutually in consultation with Board.
4) IPMS will maintain automated electronic logs for all plant operating parameters with the dynamic performance of the machines with the date and time stamp of each data log. The system should be capable of continuous data logs at five minutes or multiple of five minutes of data from each pumping sets. The data log shall be synchronized such that the data is pooled from a set of pumping sets in a pumping station together and then communicated to the remote server. It shall export the data log with the operating parameters and the dynamic efficiency of the machines for any specified period.

2.17 Integrated Information Management

The main object of the Integrated Information Management System is to assimilate the data from Integrated Performance Management Solution from various pumping stations and provide a holistic view of the entire pumping operations of the organization. The architecture of the IT infrastructure shall have maximum system reliability, operational efficiency, and ability to accommodate third-party applications at any level.

2.18 Instrumentation Details - Sensors

The distinct precision IIOT enabled sensors to be placed at right locations on each module of a pumping set. These pure data from sensors are pre-processed with sophisticated digital processing methods and high-performance analogue to digital converters.

2.18.1 Supply, Installation, Testing, and Commissioning of IOT Temperature Sensor for Motor windings with all accessories (contact or contact less)

Sl. No.	Parameters	Technical specification/range
1	Output	4-20 mA
2	Maximum temperature	0°C Up to 150°C
3	Differential temperature accuracy (absolute)	± 0.01°C or better
4	Auto zero inputs	Built-in
5	Excitation / common mode voltage	12-32 V nominal
6	Noise rejection	Eliminates: 50/60Hz, harmonics
7	Transducer principle	PT100/PT1000
8	Operating temp	0°C to 100° C
9	Material	316 L high grade stainless steel or other
10	Cable length	Upto 15 m
11	Probe length	40-50 mm
12	Diameter	6mm-10mm
13	IP rating	IP 65/IP68
14	Contact or contactless	Low resolution

2.18.2 Supply, Installation, Testing, and Commissioning of IOT Temperature sensor for Motor (Driving end and non-Driving end) – 2 Nos. for each pump with all accessories and fixtures (contact or contactless)

Sl. No.	Parameters	Technical specification/range
1	Output	4-20 mA
2	Maximum temperature	0°C Up to 150°C
3	Differential temperature accuracy (absolute)	± 0.01°C or better
4	Auto zero inputs	Built-in
7	Excitation / common mode voltage	12-32 V nominal
8	Noise rejection	Eliminates: 50/60Hz, harmonics
9	Transducer principle	PT100/PT1000
10	Operating temp	0°C to 100° C
11	Material	316 L high grade stainless steel or other
12	Cable length	Upto 15 m
13	Probe length	40-50 mm
14	Diameter	6mm-10mm
15	IP rating	IP 65/IP68
16	Contact or contactless	Low resolution

2.18.3 Supply, Installation, Testing, and Commissioning of IOT Temperature sensor for Pump (Driving end and non-Driving end) – 2 Nos. for each pump with all accessories and fixtures (contact or contactless)

Sl. No.	Parameters	Technical specification/range
1	Output	4-20 mA
2	Maximum temperature	0°C Up to 150°C
3	Differential temperature accuracy (absolute)	± 0.01°C or better
4	Auto zero inputs	Built-in
5	Excitation / common mode voltage	12-32 V nominal
6	Noise rejection	Eliminates: 50/60Hz, harmonics
7	Transducer principle	PT100/PT1000
8	Operating temp	0°C to 100° C
9	Material	316 L high grade stainless steel or other
10	Cable length	Upto 15 m

11	Probe length	40-50 mm
12	Diameter	6mm-10mm
13	IP rating	IP 65/IP68
14	Contact or contactless	Low resolution

2.18.4 Supply, Installation, Testing, and Commissioning of Artificial Intelligence driven Electric Motor Diagnosis Solution.

These Artificial Intelligence driven Electric Motor Diagnosis Solution should monitor the motor in 24 x 7 and provide any abnormalities, type of faults (Electrical & Mechanical), Voltage & Current waveforms and to be calibrated to meet the accuracy requirements of the entire test setup.

Sl. No	Parameters	Technical specification/range
1	System type	Panel-mounted condition monitoring, energy monitoring, and optimisation system
2	Operation	Continuous 24×7 monitoring
3	Functionality	Identifies equipment health, detects faults, quantifies energy wastage
4	Coverage	Complete pump systems, any motor size/voltage
5	Electrical Fault	Power quality, phase unbalance, harmonic distortion
6	Mechanical Fault	Motor, transmission system, driven machine issues
7	Process Fault	Cavitation, pressure pulsations
8	Prediction	Present, 1 month ahead, 3 months ahead
9	Fault Forecasting	Predictive outputs for expected fault severity up to 3 months
10	Fault Tracking	Identifies, diagnoses, and trends each fault separately
11	Drill-down Capability	From overall condition → fault condition → trend plots → spectra → voltage/current waveforms
12	Fault Analysis output	Nature, cause, effect, system reasoning, and recommended corrective action
13	Learning Period	Same-day installation outputs (no long training)
14	Comparison Capability	Compare same or different pump types across Station
15	Network Interfaces	Ethernet RJ45 (LAN/internet), optional LTE 3G/4G

16	DC input	5V DC, 30W (barrel lead supplied)
17	AC input	100-240V AC, 50 Hz
18	Supplied Accessories	IEC7 lead and 100-240V AC to 5V DC Adaptor
19	EMC	BSEN 61326, BSEN 61000
20	Safety	BSEN 61010
21	RED	BSEN 62311, BSEN 60950
22	RoHS	BSEN 50581

2.18.5 Supply, Installation, Testing, and Commissioning of IOT Pressure Transmitter for Suction Side of pump with all accessories and fixture

These pressure transducers are to take pressure measurements from suction and discharge side of the pump, Common Discharge transmission line, Surge vessel. These pressure transducers are for the measurement of thermodynamic pump performance applications and to be calibrated to meet the accuracy requirements of the entire test setup

Sl. No.	**Parameters**	**Technical specification/ range**
1	Output	4-20mA/ Modbus.
2	Maximum pressure range	0 to 40 bar
3	Pressure accuracy	± 0.2% of reading
4	Excitation / common mode voltage	3.3V-12 V
5	Burst pressure	6x rated pressure
6	Pressure measurement accuracy	± 0.1%
7	Operating temperature	0ºC to 80º C
8	Temperature range	0ºC to 80ºC
9	Temp effects	Typical thermal zero , ±- 0.01%/FS/ º C, an coefficients of +/- 0.015%/ deg C
10	Acceleraton sensitivity	0.006% FS/g for 0.3 bar, decreasing to 0.0002% FS/g for 30 bar
11	Mechanical shock	1000g for 1 ms half sine pulse in each of 3 mutually perpendicular axis will not affect calibration
12	Material	316 L high grade stainless steel
13	Fluids connection	Water
14	Calibration process methodology	ISO/IEC 17025

15	Cable length	0.5 - 10 meteres
16	Safety features	Safety cable assembly to control probe insertion/removal to ensure probe position and so on
17	Ingress protection rating	IP 65-68

2.18.6Supply, Installation, Testing, and Commissioning of IOT Pressure Transmitter/ pressure sensor for Common discharge transmission line, surge vessel with all accessories and fixture

These pressure transducers are to take pressure measurements Common Discharge transmission line, Surge vessel.

Sl. No.	Parameters	Technical specification/ range
1	Output	4-20mA.
2	Maximum pressure range	0 to 40 bar
3	Pressure accuracy	± 0.5% of reading
4	Auto zero inputs	Built-in / customisable
5	Excitation / common mode voltage	18V -32 V
6	Burst pressure	6x rated pressure
7	Pressure measurement accuracy	± 0.5%
8	Operating temperature	0°C to 80° C
9	Temperature range	0°C to 80°C
10	Acceleration sensitivity	0.006% FS/g for 0.3 bar, decreasing to 0.0002% FS/g for 30 bar
11	Mechanical shock	1000g for 1 ms half sine pulse in each of 3 mutually perpendicular axis will not affect calibration
12	Material	316 L high grade stainless steel
13	Fluids connection	Water
14	Ingress protection rating	IP 65-68

2.18.7Supply, Installation, Testing, and Commissioning of IOT Accelero Sensor / Accelerometer / vibration sensor for Motor with all accessories and fixtures

Sl. No.	Parameters	Technical specification/range

1	Mounted Base Resonance	5kHz min
2	Frequency Response	10Hz (600cpm) to 1kHz (60kcpm) ± 5% - ISO10816
3	Isolation	Base isolated
4	Range	50g peak (1 D , 3D, mm/Sec)
5	Transverse Sensitivity	Less than 5%
6	Case Material	Stainless Steel
7	Sensing Element/Construction	PZT/Compression
8	Current Output	4-20mA DC proportional to Velocity Range
9	Supply Voltage	15-30 Volts DC (for 4-20mA)
10	Cable length	10 Mtr
14	IP rating	IP 65 (IP68- optional)

2.18.8 Supply, Installation, Testing, and Commissioning of 800mm dia Inline Electromagnetic Flow Meter

These Electromagnetic Flow Meter will be used to measure the flow of water of individual Pump pipeline:

a)	**General**:		
(i)	Accuracy of flow measurement during FAT		± 0.5% of measured value
(ii)	Overall accuracy of flow measurement loop.		± 1.0 % of measured value
b)	**Flow tube**		
(i)	Application	:	a) Treated water pumping mains.
(ii)	Type	:	In line full bore electromagnetic
(iii)	Size of flow tube	:	Same as pipe size
(iv)	Process connection	:	Flanged
(v)	Weather Protection Class	:	IP 68 as per IS 13947
(vi)	Material of Construction :		
	Electrodes	:	SS 316
	Coil Housing	:	SS 316
	Flanges	:	SS.316
	Grounding ring	:	SS 316
(vii)	Flow tube Lining	:	*Hard Rubber* [1]
c)	Flow Transmitter Unit		
(i)	Type	:	Microprocessor based with facility to configure the ranges.
(ii)	Type of display	:	4 digit backlit LCD / LCD , for flow

1

a)	**General**:		
			rate in m3/hr. 8 digit backlit LCD / LCD for totalized flow in ML
(iii)	Units of display	:	Flow rate - Cubic metre / hr Totalized flow – Million Litre
(iv)	Input	:	From flow tube
(v)	Output	:	4-20 mA DC (isolated) proportional to flow rate
(vi)	Power Supply	:	24 V DC
(vii)	Zero and Span Adjustment	:	Required
(viiii)	Weather Protection Class	:	IP 65 as per IS 13947
(ix)	Battery backup for totalized flow Type Capacity Backup Time	:	 Online 2.5 mVA 8 hours.
(x)	Facility for on line diagnosis	:	Required

2.18.9 Supply, Installation, Testing, and Commissioning of IOT Noise Sensor with all accessories and fixtures – Not Applicable

Sl. No.	Parameters	Technical specification/range
1	Noise measure range	1- 140dBA
2	Working temperature	0- 80 degree C
3	Input power	5V- 24V
4	Output signal	4-20 mA
5	IP rating	IP65 (IP68 optional)

2.18.10 Supply, Installation, Testing, and Commissioning of IOT RPM Sensor with Transmitter with all accessories and fixtures – Not Applicable

Sl. No.	Parameters	Technical specification/range
1	Nominal voltage DC [V]	10 - 36
2	Nominal voltage tolerance [%]	< 10
3	Analogue current output [mA]	4 - 20

4	Sensing range [mm]	10
5	Measuring range [Imp/min]	5 - 3600
6	Ambient temperature [°C]	-40 - 60
7	Max. relative air humidity [%]	80; (40 °C: 50 %)
8	Magnetic actuation type	unipolar/ bipolar omnipolar
9	Protection	IP65/68

2.18.11 Supply, Installation, Testing, and Commissioning of IOT Level Transmitter with Indicator with Level Switch with programmable latch. For Water Tank Level (6m– 4 Levels) with all accessories and fixtures

Sl. No.	Parameters	Technical specification/range
1	Output	4-20mA / Modbus
2	Operating voltage	12 to 35 V DC
3	Sensors	Radar based.
4	Range	1-50 meters or Site Specific
5	Deviation	<2mm
6	Operating temperature	0°C to 50°C
7	Operating frequency	Up to 80GHz
8	Process pressure	1 to 3 bar / or higher based on site condition
9	Calibration process methodology	ISO
10	Cable length	10 -100 meters
11	IP rating	IP 67 (IP68- optional)

2.18.12 Supply, Installation, Testing, and Commissioning of IIOT Web camera with all accessories and fixtures – Not Applicable

Sl. No.	Parameters	Technical specification/range
1	Video Resolution	HD (Full HD optional)
2	Output:	MPEG4 and above or .avi
3	Enclosure	IP65/68
4	Connectivity/recording	NVR with minimum 5TB expandable storage

5	Local and Cloud view	Yes

2.18.13 Supply, Installation, Testing, and Commissioning of Field Instruments Cabinets and SMPS + MCB with all accessories and fixtures.

Sl. No.	Description	Technical specification/range
1	Nominal input voltage range	100 V AC ... 240 V AC
2	Electric strength, max.	300 V AC
3	Inrush current	< 15 A
4	AC frequency range	45 Hz ... 65 Hz
5	Protective circuit	Transient surge protection; Varistor
6	Power factor	0.94
7	Input fuse	5 A (slow-blow, internal)
8	Efficiency	> 90 % (for 230 V AC and nominal values)
9	Nominal output voltage	24 V DC ±1 %
10	Nominal output current	5 A
11	Output power	120 W
12	Insulation voltage input/output	4 kV AC
13	Short circuit and Overload Protection at Output	Protected
14	Miniature Circuit Breaker (MCB)	2P circuit breaker (MCB) with 2 protected poles and C tipping curve
15	SMPS switch mode power supply	230VAC to 24VDC/5A
16	To be fixed with Pump Monitoring Station	

2.18.14 Supply, Installation, Testing, and Commissioning of IIOT Moisture Sensor to be placed on bearing cover (water content in oil/grease) with all accessories and fixtures.

Sl. No.	Parameters	Technical specification/range
1	Working range	0...1 / 0...100 000 ppm (ppm output is valid in the range 0...100 °C (32...212 °F))
2	Accuracy at 20°C (68°F)	±0.02
3	Response time	10 min
4	Maximum working	-40...100 °C

	range	
5	output	4 - 20 mA / RS485
6	Power supply class III3)	10 - 28V DC
7	Pressure rating	0...20 bar
8	Enclosure material	Stainless steel 1.4404 (AISI 316L)
9	Protection rating	IP65 / NEMA 4
10	Filter	Stainless steel
11	Oil temperature	-40...80 °C
12	Ambient temperature	-40...60 °C
13	Electromagnetic compatibility	EN 61326-1 EN 61326-2-3 Industrial environment FCC Part15 Class A ICES-003 Class A

2.18.15 Supply, Installation, Testing, and Commissioning of Thermal Image Sensor / camera with all accessories and fixtures – Not Applicable

Sl. No.	**Parameters**	**Technical specification/range**
1	Resolution	384x288 / 640x480/ or higher
2	Frame Rate	9Hz / 30Hz
3	NETD (Noise Equivalent Temperature Difference))	<= 50mK
4	Wavelength band	8 ~ 14 µm
5	Power	USB/ rechargeable battery
6	Pitch	384x288, 17
7	Sensitivity (NETD)	< 50mk @F/1, 300K < 80mk @F/1.3, 300K
8	Operating temperature	-10°C ~ 50°C
9	Wavelength band	8 ~ 14 µm
10	Scene range temperature	-10°C ~ 250°C
11	IP rating	IP 65 (IP68- optional)

2.18.16 Supply, Installation, Testing, and Commissioning of Touch Screen Pump Monitoring Station for individual pump with all accessories and fixtures.

Sl.	**Parameters**	**Technical specification/range**

No.		
1	Touch screen display	15.6 inch
2	Operating system	Android/ windows 10 embedded/IIOT
3	Power input	230 V or 12-19V DC
4	Enclosure	IP65
5	Kiosk Panel	Custom design as per site condition

2.18.17 Supply, Installation, Testing, and Commissioning of Edge Hardware with all accessories and fixtures.

Sl. No.	**Description**	**Technical requirement**
1	Processor	Intel® 6th Generation Smart Core™ i5 processor and higher
2	RAM	2*DDR4 SODIMM memory slot, support dual channel 2133MHz memory, maximum support 32GB or higher configuration
3	Storage	SATA: 1*2.5-inch hard drive expansion Solid state drive: 1* MSATA SSD solid state drive expansion, transmission speed up to 6Gbps
4	Front panel interface	POWER: 1*power switch, 1*reset switch AC LOSS: 1*AC LOSS (Toggle switch when power on) USB: 3* USB2.0 interface, 1* built-in USB dongle Phoenix terminal: 1*12pin, support four in and four out GPIO, with isolation, switch, 5V COM: 2* DB9 RS232 serial interface, COM9, COM10 support RS485 function, with isolation SIM :1* SIM card slot, 3G/4G module application (2* SIM preferred)
5	Rear panel interface	Display interface :1*VGA port, 1*HDMI1.4 port, 1* DVI port LAN: 2*Intel® WGI211AT gigabit network card, support Wake on LAN, PXE function USB: 4* USB3.0 interface. COM: 8* DB9 RS232 serial interface, COM1.COM2 supports the 9th pin with power, COM7, PS2 :1*PS2 interface Audio: 1* Line out interface, 1* MIC interface

		power supply: 1* DC power adapter interface, 1* 3pin power interface, support 9~36V power input
6	Interface support	10* DB9 RS232 serial interface or more
7	Networks cards	Support 2* WGI211AT gigabit network card, support Wake on LAN, PXE function
8	Displays	independent three displays, 1*HDMI, 1*VGA and 1* DVI interface or higher
9	Software support	Microsoft: Windows 10, 64bit (without key) Linux: Ubuntu Watch Dog: Support hardware reset function (256 levels, 0~255 seconds)
10	Surroundings	Operating: -10℃to 60℃ storage: -20℃ to 70℃ Relative humidity: 5% - 95% relative humidity, non-condensing Job vibration: 0.5g rms/5-500HZ/random/operating
11	Enclosure	All aluminium alloy fan less industrial computer IP 65/ 68
12	Input	Wired, optical, Wi-Fi and Sub Giga hertz Radio signals in customisable and configurable data type and formats
13	Output	Wired, optical, Wi-Fi, Sub Giga hertz Radio signals in customisable and configurable data type and formats, VGA, HDMI and other
14	Al Algorithm	Tailor made configurable Machine learning based algorithm tool which runs in real timei.e. Real time robust condition monitoring based system shall be considered.

2.18.18 Supply, Installation, Testing, and Commissioning of IoT Station for each Pumping Station – Common Touch Screen data console with web based fully Pump Performance Management Solution and Remote Data management Cloud Software License with all accessories and fixtures

Sl. No.	Description	Technical requirement
1	ADC- 24 bits or higher	24 bits of NO missing codes
2	Rejection	Simultaneous (50Hz and 60 Hz) - 90 dB minimum
3	Settling	Single cycle
4	Signal conditioner	Customizable based on transducer
5	Calibration	On chip and external through

		assembly programming
6	Programmable gain amplification	1 to 128 or higher
7	Power consumption	Few micro watts

Additional features:

- High accuracy through Dual slope, Clock speed is 200MHz.
- Proprietary robust signal conditioner.
- Enhancing speed of ADC: Flash type design
- Input-referred offset voltage: < 1 LSB
- Input-referred noise: < 1 LSB
- Comparison for differential input< 1 LSB

2.18.19 Managed switch

Sl. No.	Description	Technical requirement
1	Gigabit Ethernet ports	24x1G port:
2	Uplink ports	4 x 1G SFP- 4 x 10G SFP4 x 1G SFP+
3	PoE ports	24xPoE, PoE+
4	Management type	Managed
5	Data link protocol	IPv6, Ethernet
6	Wireless Communication Standard	802.11a, 802.11b, 802.11ac,
7	Advanced Network Features	Static routing, QoS, Voice/Guest VLAN, GVRP, MSTP, Time-based Access Control Lists, IPv6
8	Advanced Security	Advanced 802.1x, Web-based Authentication, IP Source Guard, IPv6 First Hop Security, Dynamic ARP Inspection
9	Power supply	Internal

2.19 Secured communication

2.19.1 The solution should have Secured communication between Devices at the pump Station and cloud infrastructure having following minimum features and technical requirements.

The data should be encrypted between all the devices and the cloud infrastructure having minimum following encryption and communication capabilities.

Sl. No.	Type	Description
1	Minimum of 128-bit encryption.	Upgradable upto Layer 7
2	Isolation between one hardware unit to other	Isolated at physical and data layer
3	All encryption implementations should be as per legal requirements and restrictions.	Based on organization and as per state governance requirement.
4	Communication between sensors to edge devices	Wired, wireless, LAN, optical
5	Communication between edge devices and Cloud	• 4G/5G, leased internet lines (optical/LAN). • 2G support optional

A. Minimum Features

- **Bi -** directional communication between cloudand multi-SIMbased IIOT gateway
- **Cloud service/Platform:** On demand hybrid cloud
- **Platform:** Private, and OR Public
- **OS:** Linux and OR Windows
- **Proprietary cloud platform:** Configurable as per customer requirements and specifications

B. Technical Requirements

Sl. No.	Description	Technical requirement
1	Computer system resources	Real time dynamic facility: On demand upgrade and downgrade.
2	Data storage	Real time dynamic facility: On demand upgrade and downgrade.
3	User management	Automatic
4	Cloud infrastructure	Storage within India (as per Government regulations)
5	Locations	Multiple within the country
6	Networking	Secured
7	Database	Server specific or customizable
8	Identity & access management (IAM).	AS per organization configuration setting

9	Security level	L2 to Lx
10	Data storage	As per Government of India specifications and regulations

C. Optical Fibre internet

Sl. No.	Description	Technical requirement
1	Speed:	Unlimited 200Mbps and above with 24x7 promised speed.
2	Router	Auto trouble shooting routers.
3	Speed adjustment	Auto adjusting upload/download speed
4	Call	WiFi (5/2.4GHz) calling along with landline.
5	Customer support	24x7 customer support.
6	Network monitoring	Proactive network monitoring.
7	Power supply	Rechargeable built-in power supply.

2.19.2 Mobile internet (SIM1, SIM2: eSIM card Optional) – From distinct mobile service providers

Sl. No.	Description	Technical requirement
1	Speed:	Unlimited 200Mbps and above with 24x7 promised speed.
2	Data rollover	Data rollover 500 GB and above
3	Calls per day	Unlimited
4	SMS per day (Optional)	Unlimited
Additional features: • Slot based dual SIM facility • Customised software algorithm to operate in embedded OS based AI Edge device.		

2.19.3 Software Licenses & Intellectual Property Rights

Sl. No.	Description	Technical requirement
1	IP rights	All software’s provided for the project shall include a contract

		period License for all applications used in the project. However, the source code of all applications and the Intellectual property rights of standard products will remain with the respective manufacturers/Developers. The quoted price shall include the cost of servers and cloud-based services during the contract period.

2.19.4 Supply, Installation, Testing, and Commissioning of Instruments & power supply cables, supply, laying, termination, and testing as per site requirements.

Sl. No.	Description
1	Industrial grade CAT 6 cable
2	Industrial grade 4 core shielded cable
3	Industrial grade power supply: 24 VDC
4	Industrial grade DC power cable
5	GI coated MS/Aluminium/ PVC raceway for wiring
6	BIS certified

2.19.5 Supply, Installation, Testing, and Commissioning of Mobile App for Android and Apple. (Common for all the pumping Stations)

Data Integration from Various Pumping Stations that can be monitored and configured for user specific alarms and queried for various performance trends and automatedalerts.

Sl.No.	Specifications
1	Mobile application: It is supposed to be Hybrid app & should work on browser independent and work both on android and iPhone operating system based mobile phones.
2	Board User should be able to view and upload information based in his/her accessing privileges and rights.
3	Access is only for authorised board personnel using designated phone numbers.
4	Access rights are available only during duty hours for technicians.
5	The Board decides all rights on access rights and it should be communicated to the super admin user to make changes in the configuration
6	Mobile should display the following information in real-time both individual pumping set and pumping stations at all three locations a. Total Head. b. Total Flow. c. Power quality. d. Efficiency. e. Alarms with previous instances with date and time (24-hour scale).

	i.e. Real time monitoring of all sensors and associated derived parameters should be displayed in local , cloud monitor and mobile phone for a 24 hour scale.

Note:

- BWSSB will allow bidder to have connection for data gathering from their energy meter installed in pane.

2.20 Particular Control & AutomationRequirements

2.20.1 General

This part covers the Particular requirements for the design, supply, installation, Inspection and testing of IOT Based Supervisory Control and Data Acquisition (SCADA) and associated Pumping Stations and materials.

2.20.2 HMI

The HMI shall be with 16” Color screen and with touch screen capabilities.

All Remote I/O panels which are connected to the main Pumping StationsIOT based SCADA system shall be equipped with a panel HMI. The HMI shall be suitable for day-to-day operation by non-computer literate personnel in the monitoring and operation of the works. Control panel at J.K Doddi shall be provided with 16” color touch screen HMI in addition to the panel HMI at the CWPS.

The HMI shall provide efficient and safe operation of the process Pumping Stations by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all important system parameters and providing facilities for Pumping Stations optimization**& ensuring correct actions in place by Operator’s feedback to the IPMS**.

Even though present operation of the Pumping station shall be in total Manual mode from the local stations / Switchgears, the system shall have provision to allow operators, technicians and Employer Representatives to issue commands to change system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities from Individual Pump Monitoring Panels / IoT Station in the Control Room.

In future, if the Pump-motor sets are replaced / revamped, functioning of IPMS shall remain intact and shall adopt to the new system with out any major changes (like replacement of few sensor, sensor cables etc.).

The System shall perform all the necessary functions for the optimum monitoring, control and operation of the particular system. HMI unit along with software packages shall be considered, and also those software packages and Hardware shall be compatible with TCP / IP protocols as well as OPC communication (Open Standard Communication)

2.20.3 Design and Construction Requirements

J.K Doddi surge control system

J.K Doddi surge control system shall be provided as redundant remote telemetry unit (**RTU)** to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities .The surge control system shall also be equipped with redundant GPRS communication equipment to transfer the operational data to CWPS control system for monitoring. The remote telemetry unit shall be designed and include 30 % extra modules of installed capacity for each type of module shall be provided as spare and shall be wired. In addition to the above, provision shall be made for future expansion of additional 20% extra I/O modules of the installed capacity in the panel. The panel drawings shall reflect the same. The RTU system shall be installed in a free standing panel and shall conform to the major panel specifications specified in the document. The panel shall be designed and sized tointegrate with the the redundant GPRS communication network. The entire surge control system shall be powered by online un-interruptible power supply system with minimum 120 minutes back up. The status of the UPS system, GPRS system shall be monitored by the RTU system and the data communicated to the CWPS control system,for monitoring in real time basis.

2.20.4 CWPS:

In particular, the following configuration shall be applicable across the CWPS. CWPS PLC shall be provided as a Hot-Standby configuration to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities.

2.20.5 Main Pumping Stations PLC: Hot standby PLC

Main PLC system shall comprise of necessary hot standby PLC processors, Simplex input/output (I/O) modules(duplex I/O modules shall be provided for only critical inputs/outputs, the same shall be decided during detail design engineering),

redundant communication interface modules, redundant power supply modules and Human-Machine Interface (HMI) required performing the desired functions.

- PLC shall have the following attributes as a Hot Stand-by Controller.
- carry out sequential logic implementation for operations of Pumping Stations;
- carry out computation and interfacing for data acquisition, data storage and retrieval;
- it shall accept downloaded program from a programmer;
- it shall have different functional modules to perform the desired functions;
- it shall scan the inputs in time cycles and update the status of its outputs.

The PLC system shall be expandable, OPC Compatible and shall be modular in construction, so as to be capable of future expansion without hardware modifications. PLC s shall be microprocessor based. PLC s shall use standard known protocols and structures for communication outside the system.

In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be ‘off’). The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

All PLC & RIO Systems shall be housed in air-conditioned environment. The contractor shall submit the sizing calculations for the air conditioning system for review and approval.

The contractor shall refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

2.20.6 Remote input/output modules (RIO)/Panels

Individual Process locations: RIO panel with redundant RIO modules and power supply and communication modules, with simplex I/O modules(duplex IO’s shall be considered for critical inputs and outputs). The process systems shall be furnished with individual RIO panels with RIO modules which shall communicate with the main Pumping Stations PLC for monitoring and control. Minimum 16” Color panel mounted HMI with touch screen functionality shall also be provided for all RIO panels. It shall be possible to view and acknowledge the alarms and view set points for the particular processand the subsequent processes from the HMI for monitoring and control.

2.20.7 I/O Modules:

Standard rack mounted plug in I/O modules shall be provided. I/O Modules shall be of the same series as the PLC CPU. Refer the approved vendor list for the PLC system and hardware, elsewhere in this document. All I/O modules shall be hot swappable.

Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors. I/O Modules shall be hot swappable. 30 % extra modules of installed capacity for each type of module shall be provided as spare. In addition to the above, provision shall be made for future expansion of additional 20% extra I/O modules of the installed capacity in the panel. The panel drawings shall reflect the same.

2.20.7.1 I/O modules shall be as follows:

a) inputs shall be opto isolated.;
b) filters shall be provided for noise rejection;
c) output status shall be indicated by an LED;
d) all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
e) all the modules shall be of addressable type.
f) Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 Base T connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.

Each PLC shall have memory protected built in historical archiving/data logging of system alarms & events and process variables. Data logger shall be able to log data based on time or an event. PLC shall have enough memory allocated to allow 200,000 time and data stamped discrete and /or analog values to be archived. The historical archive shall allow the oldest data to roll off the system as memory is used keeping the 200,000 most current data points available. Process point time stamping frequency shall be selectable within the configuration software. It shall be possible for the archived data to be exported in CSV format allowing use with standard spreadsheet and data software applications

The PLC system shall be expandable, OPC Compatible (OPC shall be a built-in feature of the software and hardware. No external software patch or hardware module is allowed) and shall be modular in construction, so as to be capable of future expansion without hardware modifications.

a) Dual Redundant Processors (CPU)

The master station shall be provided with two identical central processors configured such that they operate in Hot-Standby mode.

Redundant system with hot back up redundancy feature shall be built in the CPU. CPU shall have the memory expansion capability up to 7 MB.

SCADA connectivity with the CPU will be on dual Ethernet network (10/100 Mbps with open Modbus TCP/IP protocol). On the event of hardware failure in primary system the standby system will provide dual connectivity with the SCADA.

Redundancy of switch for SCADA (industrial grade managed switch) connectivity is to be provided. PLC CPU and I/O modules shall be of the same logic family.

The system shall be designed and implemented such that when the Main processor fails, the Standby one shall automatically take over. The changeover shall be seamless, smooth and without any time delay and shall not cause any disruption to the overall distributed control system and to the ongoing processes.

The PLC system shall be expandable (OPC Compatible) and shall be modular in construction, so as to capable of future expansion without hardware modifications.

The system hardware, application software and database shall be sized to accommodate a total of 50% increase in signal capacity and up to 100% increase in an individual zone.

PLC s shall be microprocessor based. PLC s shall use standard known protocols and structures for communication outside the system. In case of system failure or power supply failure the outputs shall attain a predetermined fail-safe condition (this shall normally be ‘off’). The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

CPU shall have a real time clock capability to accept a time synchronization pulse and adjust its internal clock with the pulse. CPU shall have extensive self-diagnostic facilities and watch dog timers to identify faults at card levels

Application logic programs shall be fully compliant with all five logic development methods detailed in IEC 61131-3. The PLC shall be powered by two independent sources provided by the UPS system and all internal operating supplies shall be derived from the UPS.

The power supplies, I/O modules, CPU and communication modules shall be monitored by the PLC and shall be available by report. The same shall be monitored on the SCADA screen.

During the times of the battery discharge, the PLC shall initiate an orderly self-shutdown and automatically restart on the main power restoration without the need for reloading or initiation of any kind. The PLC shall comply with the specification specified elsewhere in this specification.

b) Memory Unit

Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for the upgrading and expansion of memory to meet future demands.

Not less than 50 % spare program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM. Operating data shall be stored in a RAM fitted with an internal battery backup.

c) I/O Modules

Standard rack mounted plug in I/O modules shall be provided. I/O Modules shall be of the same series as the PLC CPU. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors. I/O Modules shall be hot swappable.

50% extra modules of installed capacity for each type of module shall be provided as spare.

i. I/O modules shall be as follows:

- inputs shall be opto isolated.;
- filters shall be provided for noise rejection;
- output status shall be indicated by an LED;
- all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
- all the modules shall be of addressable type.
- Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 BaseT connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.

d) Analogue Input Modules

They shall consist of an input isolation unit, signal conditioning unit and an analogue to digital converter (ADC). In addition, the following features shall be provided.

- cross talk attenuation
- provision for monitoring of the ADC for overflow detection
- gain amplifier with high common mode rejection ratio
- accuracy for analogue signals shall be 0.5%

e) Digital Input Modules

The following design features shall be provided.

- contact bounce protection;
- choice of type of contacts.

f) Digital Output Modules

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows:

- contact bounce protection shall be provided
- relay output shall be provided to operate pump motors and motorised valve actuators
- fail safe position in case of output module failure and fault indication

PLC’s provided under this specification shall be capable of performing the necessary logic to control the system as previously defined. These capabilities shall include, but not be limited to the following:

1) Discrete input/output	10)
2) Analog input	11)
3) Analog output	12)
4) Timers	13)
5) Pump Controller	14)
6) Pump Alternation	15)
7) Mathematical Function Blocks	16)
8) Stage Blocks	17)
9) Trending	18)

g) PLC Programming

PLC programming shall be carried using functional block diagrams (FBD). The logic shall be prepared using programming software and shall be comprehensively annotated with subroutine and rung comments to assist further development and maintenance.

The contractor shall submit the details of the PLC programming software for review and approval.

The system shall support a simple programming of the application software comply with IEC 61131-3.

The system shall support a structured, modular programming. At least the following standard operations shall be applicable:

1) Logic functions (such as AND/OR/AND NOT etc.);
2) Timer functions (externally adjustable);
3) Counter functions;
4) Skip functions;
5) Comparison functions;
6) Limit value functions;
7) Arithmetic functions;
8) Physical unit functions;
9) Closed-loop functions such as P/PI/PID/etc.

The Contractor shall submit the logic diagrams for review. The Contractor shall include the as-built logic in the final submission.

h) Programming Unit

The programming unit (16" screen) shall be of the portable type, industrial model designed to be used during commissioning on site. A functional keyboard which supports different type of programming methods shall be included, as well as a LCD display

On a minimum, the following functions shall be included:

i) On-line programming
ii) Off-line programming
iii) Flexible corrections during input
iv) Full screen editing functions
v) Absolute and symbolic programming
vi) Input of comments and title blocks for complete documentation
vii) Complete application software documentation functions. Printouts of application
viii) Software logic functions shall preferably be in Ladder logic diagrams.
ix) Load and transfer functions

The portable programming unit with minimum 16" screen shall be provided complete with proprietary PLC programming and SCADA licensed software's complete with Pumping Stations mimics and documentation software. Communications cables required to interact with the PLC, (E.g.: Modbus Cable) would be supplied by the contractor.

The portable programming unit shall be loaded with the CWPS PLC program, Surge control system RTU program and Pumping Stations mimics to monitor the same. The same shall be demonstrated during control system factory acceptance test.

i) The software shall provide facilities for:

- carrying out program revision management;
- insertion of comprehensive program subroutine and rung comments;
- search and find and search and replace 'contacts' and 'coils';
- simulation functions and testing of the program by changing the status of contacts and monitoring the outputs;

- preparation of coil and contact list and their locations and memory maps;
- make system backup copies while the system is online;
- upload and down load programs to the PLC on line;
- Carry out on line maintenance and fault finding on the PLC.

j) Ethernet Switches

The contractor shall only provide managed industrial grade Ethernet switches under this contract. All switches shall be in redundant configuration.

2.21 Minimum I/O Requirements for Auto mode Control operation of the Pumping Stations:

On a minimum, the control design shall incorporate the I/O requirements which are indicated in the table. All process & Instrumentation Diagrams (P&ID) shall incorporate & depict the minimum I/O requirements as indicated in the table below.

Design shall include complete auto mode of operation of the entire CWPS (inclusive of surge system)& J.K Doddi surge control system and associated Pumping Stations/stations with all necessary interlocks and safety mechanisms.

Minimum I/O to be provided under this contract for the Control system is as under:

Sl No	**TYPE**	**MINIMUM I/O'S TO BE CONSIDERED**
1.	Pump, Motor	Start, Stop, Available, Auto, Off, Manual, Run, Emergency Stop, Fault, Speed ref
2.	Valve	Available, ,Auto, Off, Manual, Open, Close, Travelling Indication, Fault
3.	Drives	Available, ,Start, Stop, Auto, Off, Manual, Run, Emergency Stop, Fault
4.	Level Indicator	HH, H, L, LL, Analog value,
5.	Level Switch	HH, H, L, LL,
6.	Pressure Indicator/transmitters	Shall be provided at **(**in addition to individual pumps**,** at common discharge

		end of pumps, etc...): Analog Value,
7.	Flow Indicator/Transmitters	Shall be provided at **(**in addition to other Pumping Stations flows**,** at individual discharge end of pumps, etc...): Analog value, totalizer,

2.21.1 Typical Drive Control Philosophy to be provided on a minimum shall be as follows:

SL. NO.	**DESCRIPTION**	**Type of I/O**	**No of I/O**
1.	**PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE / LT BREAKER CONTROL DRIVE (Signal Exchange has been envisaged between PLC and switchgear)**		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
	Auto, Off, Manual	DI	3
e.	Swgr. Disturbance (Overload relay operated/ control supply fail/	DI	1
	Emergency LPBS stop)	DI	1
	Available	DI	1
f.	Electrical Trip (Motor Protection Relay)	DI	1
g.	Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged) —	DI	1
	Shall be as per IPMS. The following I/O are to be provided on a minimum		
h.	Pump bearing temperature measurement	AI	2
i.	Motor Bearing temperature measurement	AI	2

SL. NO.	DESCRIPTION	Type of I/O	No of I/O
j.	Motor Winding temperature measurement	AI	6
k.	Current Transducer input	AI	1
2.	**PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE (Signal Exchange has been envisaged between PLC and PCC/MCC)**		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
	Auto, Off, Manual	DI	3
	Available	DI	1
e.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/	DI	1
	Emergency LPBS stop)	DI	1
f.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
3.	**PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE- For Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Integral starters Fault	DI	1
d.	Open limit switch feedback	DI	1
e.	Close limit switch feedback	DI	1
	Auto, Off, Manual	DI	3
	Available	DI	1
f.	Position Transmitter (For inching type Drive)	AI	1
g.	Command	AO	1
4.	**PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE-For Non-Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	Open Command	DO	1

SL. NO.	**DESCRIPTION**	**Type of I/O**	**No of I/O**
b.	Close Command	DO	1
	Auto, Off, Manual	DI	3
c.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/	DI	1
	Emergency LPBS stop)	DI	1
	Available	DI	1
d.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
e.	Open limit switch feedback	DI	1
f.	Close limit switch feedback	DI	1
g.	Position Transmitter (For inching type Drive)	AI	1
5.	**PLC INTERFACE FOR SOLENOID DRIVE (Single coil)**		
a.	Energise or Deenergise	DO	1
b.	Open limit switch feedback	DI	1
c.	Close limit switch feedback	DI	1
6.	**PLC INTERFACE FOR SOLENOID DRIVE (Double coil)**		
a.	Energise	DO	1
b.	Deenergise	DO	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
7.	**PLC INTERFACE FOR PNEUMATIC DRIVE**		
a.	Command to I/P converter	AO	1
b.	Position Transmitter	AI	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
e.	Command to Solenoid valve (Wherever applicable)	DO	1

2.22 Surge System:

System Description as given below is to help understanding the requirement so that Contractor can design & supply the Instrumentation for Surge Vessel System.

Pressure Vessels

(a) Air vessels should be suitable to take care of the water hammer/ pressure surges which may occur in the pipeline systems on which they are proposed. The air vessels shall be manufactured out of MS plates as per IS 2002. The nozzles shall be seamless conforming to SA 106 Grade B. Flanges up to 250 NB shall be of weld neck type of forged quality conforming to SA 105. The design and fabrication will be carried out as per latest version of IS 2825. The vessel shall be designed for the maximum system pressure with 10% design margin and with a corrosion allowance of 3 mm. At least 10% of the weld joints on the vessel shall be spot radio graphed. 100% of the weld joints, if any, on the dish shall be radio graphed. Air vessels will be provided with manholes and water outlets at the bottom, which will be connected to the rising mains along with an isolating valve and a differential orifice. Suitable drains are to be provided for maintenance. Air vessels will have standard fittings such as pressure relief valve, visual level indicators, control circuit inlets and outlets, etc., with isolating valves. Inspection for air vessels shall cover welding qualifications, radiography / UT / PT/ MT as applicable, Stage/ in-process inspection, and hydro/ leak tests.

(b) Two air compressors shall be supplied along with each air vessel. These compressors will be operating at a slightly higher pressure than the pressure in the water main, and compressed air will be stored in the receiver from which requisite supply will be made to the air vessel. Inspection of compressors shall cover dimensional checks for mounting and overall dimensions, performance tests, and hydraulic leak tests. The air vessel and air receiver will be painted internally and externally with zinc rich food grade epoxy paint.

(c) The following additional equipment will be supplied as standard accessories for each

air vessel:

i. Receiver with compressor, with automatic on/off system.
ii. Visual water level indicator, covering full height or length of the air vessel.
iii. Isolating and drain valves for maintenance purpose.

2.23 Surge Suppression System

The automatic surge / water hammer control system shall be generally as described below. Contractor may propose alternative arrangement.

(a) The surge protection system shall comprise of air compressors, common air receivers, surge vessels, field instruments and control panel with facilities for alarm annunciation and for operation and monitoring of compressor and air inlet valves of surge vessels. The surge vessels shall be connected with the common air header from the air receiver and at the base to the pumping station discharge header via the buffer manifold. The air inlet pipe to the surge vessels shall be provided with electrically / pneumatically operated valves to control air input to the surge vessels and an electrically / pneumatically operated valve to control air release from the surge vessel. For controlling the water level within the surge vessel, the vessel shall be provided with a conductivity type level switch. For continuous monitoring of water level within the surge vessel, capacitance type level measuring system shall be provided. A magnetic liquid level gauge shall also be provided to permit the visual monitoring of the water level in the surge vessels. The surge vessels shall be provided with safety air relief valve.

(b) The electrically / pneumatically operated air inlet valve shall be provided in the air inlet line of the surge vessels to permit the entry and release of air from the surge vessels. Hand operated valves shall be provided in parallel with these valves for manual control of air addition and release.

(c) Operation Philosophy:

- The surge vessels are filled with water to a given level that is within a working level band. Air is added to the top of the surge vessels to act as a cushion and maintains the water level in the surge vessels within the working band. During normal operation, air will slowly dissolve in the water causing a gradual rise of the water level in the surge vessels.
- The mean working level (i.e. between upper working level and lower working level) is maintained constant by allowing more air from the compressor air receiver to enter the surge vessels.
- When the pumps stop supplying water to the discharge header at the time of pump tripping due to power failure the non-return valve at the pump outlets will close. The water column continues to move away from the pumping station and in doing so will create a negative pressure in the discharge header.

- Water from the surge vessels is drawn into the discharge header through the surge non-return valve in order to limit the magnitude of this negative pressure and in doing so prevent damage to the pipe line. When water column reverses water enters the surge vessels through the NRV bypass line and the air in the surge vessels is compressed providing a cushioning effect to the returning water column. Energy of returning water column is absorbed due to compression of the air.
- The water level in the surge vessels shall be maintained within the working band during steady state pipeline flow conditions. The steady state water levels in the surge vessels shall be maintained between the upper and lower working level settings.
- The limits of the bands between upper and lower working levels shall be readjusted during commissioning.
- The status of the surge protection system and associated alarms shall be monitored at the ICP.
- The starting and stopping of the compressor shall be automatic with a manual override facility. The compressor shall start when there is a low air pressure in the associated air receiver and stop when the required air pressure is reached. Separate pressure switches shall be provided on air receiver for starting and stopping of compressor. The air receiver shall be provided with pressure gauge and safety relief valve.
- Conductivity type level switches shall be provided for monitoring the following levels in the surge vessel:
    i. Upper emergency level (UEL)
    ii. Upper control level (UCL)
    iii. Normal level (NL)
    iv. Lower control level (LCL)
    v. Lower emergency level (LEL)
- The level switches shall be provided on the 'stand pipe' of the surge vessel. When the level in the surge vessel reaches the 'upper working level' and remains there for certain duration of time (adjustable), the pneumatic/ electric operated air inlet valve shall open. The valve shall close when the 'mean working level' is reached.
- When the level in the surge vessels reaches the 'lower working level’ and remains there for certain duration of time (adjustable), the pneumatic/ electric operated air release valve shall open. The valve shall close when the 'mean working level' is reached.

- An orifice plate shall be provided to restrict the rate of air release to ensure restoration of the mean working level within approximately 30 minutes (to be decided during commissioning).
- A silencer shall be provided on the discharge to limit the noise made by air release. When 'upper emergency level' and 'lower emergency level' are detected by conductivity level switch, alarms shall be annunciated on the surge protection system control panel and on the main ICP. In addition water level high high and low low alarms shall be configured on the surge vessel water level analogue signal. These alarms will be used when the surge vessel water level is being controlled by hand such as when the surge vessel containing the level switches is taken out of service for maintenance. The high high and low low limits shall be set outside the digital alarm levels.
- Manual override facilities shall be provided for operating the compressor and the air inlet and air release valves. A non-return valve shall be provided on the air inlet line to the surge vessel to prevent back flow of water from the surge vessels to the air receiver.
- The logic controls may be provided in the main PLC.

(d) Instrumentation & Control System:

- A separate control panel shall be provided for operation and monitoring of the surge suppression system. The panel shall comprise the following:

(i) Incoming isolator

(ii) Starters for compressors

(iii) Automatic-Off-Manual selector switch

(iv) Status indication

(v) Start / stop pushbuttons for use in manual mode

(vi) Duty / standby compressor selector switch

(vii) Auto-manual selector switch for surge vessel air supply

(viii) Manual controls for air inlet and air release

(ix) Indication of surge vessel water level

(x) Alarm annunciator to indicate the following alarms as a minimum:

(xi) Surge vessel water level high high

(xii) Surge vessel water level high

(xiii) Surge vessel water level low

(xiv) Surge vessel water level low low

(xv) Compressor faults for each compressor as appropriate i.e. fail, oil temperature high , etc.

(xvi) Low air pressure in receiver

(xvii) All the critical alarms and signals required for safe efficient operation of pumping station shall be connected to the main PLC in ICP.

(e) Abnormal Operation

- In case working compressor fails, the standby compressor shall come into operation automatically and an alarm shall be annunciated on surge suppression control panel and ICP.
- In case the control supply to surge suppression control panel fails an alarm shall be annunciated at the ICP and the operator shall carry out the operation of surge suppression system manually.

2.24 Approved Vendor/Manufacturer/Make List-Instrumentation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

Sr. No.	**Description**	**Vendor/Manufacturer/Make**
1	LEVEL INDICATOR TRANSMITTER	M/S ABB-GERMANY M/S ENDRESS+HAUSER M/S YOKOGAWA M/S SIEMENS M/S ROYCE INSTRUMENTS M/S HITACHI HIGH-TECH M/S FORBES MARSHALL M/S SHRIDHAN INTERNATIONAL
2	FLOW METERS/FLOW INDICATOR/ TRANSMITTER (ELECTROMAGNETIC, ULTRASONIC)	M/S YOKOGAWA M/S ENDRESS+HAUSER M/S HITACHI HIGH-TECH M/S AICHI TOKEI DENKI CO LTD M/S ABB-GERMANY M/S FORBES MARSHALL
3	LEVEL/FLOAT SWITCHES	M/S ABB-GERMANY

Sr. No.	**Description**	**Vendor/Manufacturer/Make**
		M/S ENDRESS+HAUSER, M/S KROHNE GMBH GERMANY M/S P&F M/S LEVCON, M/S HITACHI HIGH-TECH M/S SHRIDHAN INTERNATIONAL
4	PRESSURE GAUGES	M/S GENERAL INSTRUMENTS M/S. BAUMER M/S MIGISHITA (JAPAN) M/S NAGANO KEIKI M/S ASAHI M/S WIKA M/S KROHNE GMBH GERMANY M/S YOKOGAWA
5	PRESSURE INDICATOR TRANSMITTER & SWITCHES	M/S EMERSON M/S ENDRESS+HAUSER M/S SIEMENS M/S. BAUMER M/S HITACHI HIGH-TECH M/S FUJI ELECTRIC M/S ABB-GERMANY M/S KROHNE GMBH GERMANY M/S YOKOGAWA
6	UN-INTERRUPTIBLE POWER SUPPLY SYSTEMS	M/S NIPPON KEIDENKI WORKS M/S FUJI ELECTRIC M/S HITACHI M/S MEIDENSHA CORPORATION M/S APC M/S FURUKAWA BATTERY M/S DELTA
7	BATTERIES	M/S SANKEN ELECTRIC M/S AMCO M/S EXIDE

Sr. No.	**Description**	**Vendor/Manufacturer/Make**
		M/S SEC M/S FURUKAWA BATTERY
8	PANELS	M/S RITTAL M/S ELDON M/S CEPL M/S HOFFMAN M/S BCH
9	CABLES	M/S UNIVERSAL CABLES M/S HAVELL'S M/S CCI M/S FINOLEX M/S POLYCAB M/S NICCO M/S DELTON CABLES LIMITED

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall preferably be the end products of one (1) manufacturer.

Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-3**:**In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are "Superior / Equivalent" to the approved makes.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to.
4) Submit product brochures for the proposed equipment.
5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
6) At least 10 successful individual installations of similar size as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date.

7) Manufacturer to provide full contact information for each reference as part of technical bid.

Note 4 : The solution offered should have been in use in any of the Government Organisation / Utilities / PSU / Corporation. Or

The solution offered should be a patented Technology granted by Government of India and duly approved / registered in Start-up India /Karnataka.

2.25 Approved Vendor/Manufacturer/Make List-Automation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

Sr. No.	**Description**	**Manufactures/Makes**		
1	WORKSTATIONS, SERVERS, LAPTOP NOTEBOOK	M/S-DELL M/S-HP M/S-FUJITSU M/S-TOSHIBA		
2	PROGRAMMABLE LOGIC CONTROLLERS & IO MODULES	**Make**	**CPU Series**	**IO Series**
		SCHNEIDER ELECTRIC	QUANTUM SERIES	QUANTUM 140 SERIES
		SIEMENS	S7-400H	ET-200M SERIES
		ALLEN BRADLEY	CONTROL LOGIX 1756 SERIES	CONTROL LOGIX 1756 SERIES
		MITSUBISHI ELECTRIC	Q12PRH	Q SERIES
		OMRON	CS1D	CS1D SERIES
		ABB	AC 800 M	S 800

				SERIES
3	SCADA PROGRAMMING SOFTWARE	WIN CC, RS VIEW, TELVENT SCADA, MC WORKS, CX-SUPERVISOR,ABILITY SYMPHONY PLUS (All software's shall be Inclusive of reporting, web server,Trends and supporting industry standard multiple protocols, inclusive of OPC gateway support) Note: All software's shall be of the latest series version and shall include both runtime and developer versions.		
4	HISTORIAN SOFTWARE	M/S SCHNEIDER ELECTRIC-TELVENT HISTORIAN M/S MITSUBISHI ELECTRIC- MC HISTORIAN M/S SIEMENS – SIMATIC PROCESS HISTORIAN M/S ALLEN BRADLEY-FACTORY TALK HISTORIAN SE M/S PROGEA- MOVICON M/S ABB- SYMPHONY PLUS HISTORIAN		
5	INTEGRATED PUMP PERFORMANCE MONITORING SYSTEM	M/S ABB-GERMANY,ROBERTSON TECHNOLOGY (AUSTRALIA), M/S JFE-ADVANTECH-JAPAN, SIEMENS or ADVANCED TECHNOLOGY		
6	REMOTE TERMINAL UNIT	M/S-SIEMENS, M/S-ABB, M/S-MITSUBISHI, M/S-OMRON, M/S TOSHIBA		
7	DC POWER SUPPLY	M/S-APLAB, M/S-WAGO, M/S-PHOENIX CONTACT, M/S-MEAN WELL, M/S-WEIDMULLER, M/S-OMRON. M/S-SHAVISION		
8	PANEL HMI	M/S-ADVANTECH, M/S-MITSUBISHI, M/S-PANASONIC, M/S-SIEMENS, M/S- M/S-ABB,		

		M/S-OMRON.M/S-TOSHIBA
9	LED MONITORS/DISPLAYS/VDU	M/S-SAMSUNG, M/S-LG, M/S-SONY,M/S-DELL,M/S-BENQ,M/S-HP
10	PRINTERS	M/S- CANON,M/S- FUJI,M/S-XEROX,M/S-EPSON,M/S-RICOH
11	CONTROL ROOM CONSOLES& FURNITURE	M/S PYROTECH WORKSPACE,M/S EVANS,M/S QUEST,M/S WINSTED

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-3**:**In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are “Superior / Equivalent” to the approved makes.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to.
4) Submit product brochures for the proposed equipment.
5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
6) At least 10 successful individual project installations of similar size and application as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date.
7) Manufacturer to provide full contact information for each reference as part of technical bid.

Note 4 : The solution offered should have been in use in any of the Government Organisation / Utilities / PSU / Corporation. Or

The solution offered should be a patented Technology granted by Government of India and duly approved / registered in Start-up India /Karnataka.

2.26 Supervisory Control and Data Acquisition System (SCADA)

The SCADA shall be a fully integrated microprocessor-based control and data acquisition system which will monitor, control, display, record and trend all assigned Pumping Stations inputs and outputs. The SCADA shall be a fully dual redundant microprocessor-based computer system such that reliable and automatic Pumping Stations control can be achieved.

The main process monitoring and control shall be by means of VDU based process operator / Engineering workstation that shall be located in the central control room.

SCADA system would be dual redundant server system. The system shall be designed and implemented such that the failure of a central processor or HMI console does not inhibit continuous automatic control of the Pumping Stations.

Failure of a single outstation or communications to that outstation shall not effect control or operation of any other outstation, unless the failed outstation provides essential data to another outstation, in which case the non-failed outstations shall revert to a fail-safe mode.

An alarm shall be generated whenever a communications system failure occurs.

SCADA shall be designed, sized and shall include the complete Pumping Stations mimics of all 3 CWPS and associated Systems including Surge Vessel & J K Dodi Instrument, such that the information from these packages shall be displayed at eachCentralised IOT Station as well as to User Interfaces over Web & Mobile App at all times, to enable the Pumping Stations operators to have complete information on upward and downward control system packages. This shall enable Pumping Stations operators to schedule the Pumping Stations operations in the event of a breakdown, failure of the components, equipment etc. at these Pumping Stations as mentioned above. Contractor to note the importance of this clause and shall include the same in the control philosophy and shall demonstrate the same during the control system factory acceptance test.
All the Operational data of each Pumping Station, Surge Vessel & J K Dodi Instrumentation shall be available at each individual Pumping Station Control System as well.

The SCADA control system shall comprise on a minimum the following but not limited to:

a) Dual redundant SCADA servers with SCADA software with minimum fifty thousand tags license and web servers:
b) Engineering Cum Operator work station loaded with SCADA software and with latest licensed Windows Operating system, minimum 1TB storage, latest processor, etc.
c) Redundant industrial managed Ethernet switches at both CWPS and J.K Doddi.
d) Licensed MS Office,Adobe licensed PDF Viewer &Antivirus software to be loaded on each system.
e) Industrial grade control system console to house the entire IOT based SCADA system and other equipment as indicated in the system configuration diagram.
f) All required software and hardware to implement the system as indicated in the specifications and system configuration drawings.

Note:*The contractor shall note that*

(i) *Redundant GPRS communication system shall function as the primary as well as secondary mode of communication for Pump Performance Monitoring System.*

(ii) *For Communication with CP-24 Package : proposed GPRS communication system shall function as the primary mode of communication till such time the FOC communication network is established under contract package CP-24.Once the FOC communication network is established and commissioned, GPRS mode of communication shall act as backup mode of communication to FOC communication network. The SCADA & communication interface shall be so designed to switch between FOC and GPRS mode of communication automatically on pre-defined intervals in order to cross verify the readiness and working of the communication system at all times. The frequency of switchover shall be minimum 2-3 times in a week.The switchover philosophy shall be detailed in the FDS . Co-ordination and interoperability testing for communication betweenCP-24& MIS-2 shall be under the scope of the contractor. Contractor to note the importance of this clause.*

The SCADA system shall follow the International Standards Organization (ISO), Open Systems Interconnect (OSI), reference model guidelines. All central system hardware and software devices shall be interconnected using a bus topology data highway. The communications protocol used shall generally meet the requirements of the ISO.

The system shall provide efficient and safe operation of the complete Pumping Stations by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all system parameters and providing complete facilities for Pumping Stations operation and optimization.

The System shall perform all the necessary functions for the optimum monitoring, control and operation of the entire system. For each abnormal condition, Pumping Stations failure, Pumping Stations unavailable or failure to respond to a command within a given period, the system shall provide the appropriate alarm.

Printed and archived alarms shall be time and date stamped for occurrence and acceptance. Alarms, logs and reports shall be output to separate printers. Alarms shall be in red. The ability to generate alarms within the system software based upon digital and / or analogue events and set points shall be provided.

An alarm horn with silence button shall be provided to alert the operator of an alarm condition. Specific alarm, monitoring and control input / output requirements shall be determined from the particular control specifications and the Project Drawings.

2.27 SCADA Software & Hardware Minimum Requirements:

General:

1) The Contractor shall be responsible for supplying complete software packages to enable the equipment to operate as stated in this specification. Provision must be made for the adding of further software tasks as and when required. All software functions shall be user friendly, with instruction and messages to aid the operator. The Contractor shall make available all standard software functions, even if not specifically detailed in the specification.
2) The computers shall utilize a real time multi-tasking and networked operating system with a proven track record in real time control applications.

3) SCADA Server stations shall be with dual monitor system, loaded with latest authorised windows server operating system, latest MS Office professional,licensed latest & proven PLC programming software,licensed SCADA software,centralized server monitored Anti virus software,required licensed network monitoring software,licensed firewall software,etc.with all accessories complete
4) SCADA operator stations,engineering stations,Historian Stations & CCTV stations with dual monitor systems, loaded with latest authorised windows operating system, latest MS Office professional,licensed SCADA software,licensed client Antivirus software,required licensed network monitoring software,etc.all accessories complete suitable for interconnection with external networks in a Wide Area Network (WAN) configuration, where specified.
5) Online & offline printers (A3 Size all in one printer), inclusive of printer servers with all accessories complete to meet the requirements.
6) Industrial Laptop 16" screen loaded with authorised windows operating system,MS Office,and PLC programming software,SCADA software licenses,Antivirus software,Interoperability software required to test the integration between sites, with all accessories complete
7) The Application Software shall provide communication with other industrial standard open networks. The Software shall support Object Linked Embedding for Process Control (OPC).OPC shall be a in-built feature of the software.
8) The System shall support a fully distributed 64 bit Client/Server architecture. The System shall include Visual Basic for Applications (VBA) as a built-in programming language. Facility shall be available for building custom objects using VBA. Object oriented graphics and tools to easily build reusable control strategies. ODBC Application Program Interface (API) capable of collecting and writing secure real-time electronic records to one or more relational database.
9) The software shall support OPC standards as both a client and a server for fast and reliable communications with a wide variety of hardware devices. Provide Active-X controls with selection of third-party Active-X controls for ready-made solutions without VBA programming. The SCADA software shall use SQL server as the integral database.

10) A standard software package, such as Crystal Report shall be provided to facilitate generation of free format, intuitive and presentation quality reports.

11) The engineering Workstation shall be provided with simulation tools to support off-line testing of the control logics.

12) The Server shall provide the master clock for the SCADA time synchronization.

13) SCADA design shall include de-activation of CTRL+ALT_DEL windows feature. The same shall be demonstrated during FAT.

14) The SCADA system shall be designed to be initialized without any operator intervention/windows login: the SCADA software and all other associated software (inclusive of windows software) shall be loaded and the main screen shall be displayed for the Pumping Stations operator to enter the login credentials, without any operator intervention to meet the criteria. The same shall be demonstrated during FAT.

15) The system software shall be from the SCADA manufacturer as indicated in the approved vendor list elsewhere in this specification. Third party software is not acceptable. It is a requirement that the system be supported by on line configuration and editing of all VDU mimic displays and database and to create new displays and additional database.

16) Both PLC hardware and SCADA software shall be from single OEM.

17) Operational mimics and other graphics shall be presented in an industry standard graphical user interface (GUI) format. A minimum of two active windows shall be displayable concurrently and not more than three windows. Both text and graphics shall resize automatically to accommodate changes made to the size of a window. The system shall be designed to minimize the operator's use of the keyboard. All major functions shall be accessible on-screen through use of the mouse.

18) SCADA shall be designed to disable right click options (from the mouse or trackball) to provide greater security to the system and to prevent un-authorised modifications to the system by the Pumping Stations operator. The same shall be demonstrated during FAT. The operator login shall not be allowed to view or modify any other function, command depending on the level of authority of the operator.

19) Operator system entry, for each area will be password coded with different levels of entry depending on the level of authority of the operator. Development and systems level entry passwords will be provided

for engineering workstations. Each action taken by any operator at any level of entry, or at any operator terminal, shall be log file recorded and time and date stamped. Log in and out time and dates will be printed on the control room event logging printer.

20) Right click menu options on SCADA software shall be designed to be disabled.

21) As dual monitor shall be utilized, the SCADA system shall be designed to display the Pumping Stations mimics on dual monitors simultaneously for monitoring and control without any interruption in Pumping Stations control and monitoring at all times. It shall be designed to display multiple & different Pumping Stations mimics screens to be displayed on the dual monitors at all times. The same shall be demonstrated during FAT.

22) All requests and commands shall be via icons, whether menu linked or linked to equipment control actions. A permanent dynamic alarm banner shall be displayed at the bottom or top of each operator screen. Each control action will be routed through a series of confirmation routines.

23) The reports shall be available for printing in graph or tabular format. Dynamic trend displays shall also be available for all analogue flow, level and pressure values. Custom, as well as preconfigured reports and trends shall be available to a higher level of entry. A colour, A3 size, multi-function printer shall be provided for graph and trend prints.

24) An operator help utility shall be provided, offering help linked to the particular action being carried out by the operator at that time. At least one help screen per screen page shall be available. This facility shall be preconfigured with an option for updating by operators, via a password entry.

25) The Application Server software shall be configurable to provide for the monitoring and control of all points, loops, and systems through graphic display screens and hard copy reports. These shall include:

- Parameter Displays for signal control
- Control Loop Status Displays
- Real Time and Historical Data Trend Displays
- Event Displays and Log Reports
- Alarm Displays and Log Reports
- Equipment Diagnostic Displays and Reports.

26) The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic

display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

27) The system shall conform to and take advantage of industry standards. These shall include, but not be limited to:

- ODBC
- OLE
- ActiveX
- COM/DCOM
- DDE and Advance DDE
- C programming language
- Visual Basic
- Microsoft Windows XP or the most current Operating System
- TCP/IP
- OPC
- XML

28) Display Facilities and screen/mimic refresh: The displays shall be user configurable, with the user being able to construct any desired symbol for display. Any display shall appear (excluding historical recall) within 1 seconds to 2 seconds of selection and the displayed data shall be updated from the database.Alarms shall typically appear within 3 seconds to 5 seconds of occurrence and within 1 second of being received into the central system database. Pumping Stations mimics shall display dynamic color details of flow rates and pressures, pump status, well levels, alarms, electrical power supplies and other general equipment status conditions. The Pumping Stations mimics shall include animation to depict completePumping Stations process operation, pump running station, media flow within the Pumping Stations, levels in the tank, etc. The animation shall be designed such that the screen refresh rate shall not affected. and shall be maintained within 4.16 msecs. The refresh rates shall be 240Hz.The SCADA servers and workstations, monitors (engineering & operator) shall be suitably chosen to meet this requirement.

29) The Contractor shall configure all display pages as fully as possible. However, facility must be incorporated to permit easy construction and modification of the display pages, by using a standard library of shapes and symbols. The library shall be added to and modified by the user as required. The configuration shall be object orientated for ease of use.

30) The initial application software shall provide for the display pages listed below and any pages necessary for the system to function as a complete entity.
   a) Mimic displays
   b) Graphic displays.
   c) Trend displays.
   d) Alarm summary tables with date and time.
   e) Event logs of past 72 hours with date and time.
   f) Tabular display of data.
   g) Inset windows showing an analogue trends may be mixed with mimic displays. In such a display the main mimic and inset trend shall all be live with automatic display updates.
   h) Indexing of information and menus shall be presented in the form of active windows on the screen, while the mimics etc. are still available for view.
   i) No display or function shall effect the logging/monitoring of data. It shall be possible for the master station terminal and auxiliary terminals to perform simultaneously, different tasks within the display.

2.28 Monitoring and Alarms

1) The operator shall be able to monitor all of the information at the workstation. He shall be able to view active equipment information by use of graphical and tabular displays.
2) In the event of an equipment alarm, the following shall occur at the master station:
   a) Alarm message displayed in the alarm message area of the screen.
   b) The audible alarm shall sound.
   c) The appropriate Section of the display page shall change color and flash.
   d) A full message shall be written on the alarm page.
   e) The full alarm message shall be printed on the alarm printer.
   f) The full alarm message shall be recorded, stored on disk and automatically archived.
3) The operator shall be able to acknowledge the alarm by pressing an accept alarm key or icon. This action shall stop flashing of all associated alarm messages and displays. However the display shall remain in the alarm

state fixed color to indicate an accepted alarm. When all outstanding alarms have been acknowledged the audible alarm shall be silenced.

4) Once the alarm has cleared, the messages and displays shall return to normal. The alarm message shall stay recorded on the event/alarm log and an alarm cleared message shall also be recorded.
5) If the alarm clears before being acknowledged the sequence of events shall continue as above except the message shall change to indicate a cleared alarm.
6) An audible alarm silence function shall be provided to enable an operator to silence the audible alarm without acknowledging all alarms. On occurrence of any subsequent alarm, the audible alarm shall sound.
7) Each signal within the configured system shall be capable of being assigned an alarm based on the following:
   a) Four levels per analogue (Lo Lo, Hi Hi, Lo and Hi).
   b) Rate of change.
   c) Deviation from set point or other control parameter.
8) Alarms shall be time tagged to 1 second resolution at the I/O's.
9) A minimum of four alarm priorities shall be provided so that those requiring immediate attention may be separated from alarms of lower priority. An audible alarm shall sound for alarms requiring operator action.
10) Typical alarm assignments are as follows:
   a) critical alarm-an alarm that requires immediate operator action
   b) non critical alarm-an alarm that requires operator action but notnecessarily
      immediate action
   c) operator guide alarm-an alarm that provides information to the operator
   d) event-a low priority condition which is recorded.

2.29 Data Archiving

Continuous process (analogue) data, digital event states, alarms and operator actions shall be archived to a removable media system. The archive media shall be sized to store logged analogue data, at a maximum sample rate of 15 minutes for a period of three months locally. Data recording shall be on dual media. The archive system shall generate an alarm when a file is 60% full.

Analogues will be stored at a rate selected by the operator in the range 1 second to 1 hour. The operator shall have the facility to select the way in which an analogue is stored.

The system will provide any combination of the following:

- Instantaneous value.
- Average value.
- Maximum value.
- Minimum value.
- Not stored.

Maximum, minimum and average values shall be calculated over a period set by the operator in the range 15 minutes to 24 hours, the default shall be 1 hour.

The logging of new data and reception of alarms must be carried out at the same time as the operator is viewing archived data. Any alarms received must be displayed as an overlay on the visual display unit.

The contractor shall submit the data archiving policy to be adopted as part of functional design specifications for review and approval. The same shall be demonstrated during the factory acceptance test and site acceptance test.

2.30 SCADA Screens/Mimics

The Contractor shall configure all the mimics to provide total detailed coverage of the monitoring and control of equipment as detailed in this specification. It is expected that display modifications will be required in the future and therefore the ability to change the displays without programming skills is essential.

The Pumping Stations mimics shall include dynamic animation to depict completePumping Stations process operation, pump running station, media flow within the Pumping Stations, levels in the tank, etc. The animation shall be designed such that the screen refresh rate shall not effected and shall be maintained within 4.16 msecs at all times. The refresh rates shall be 240Hz.The SCADA servers and workstations , monitors (engineering & operator) shall be suitably chosen to meet this requirement.

Instrumentation shall be displayed using ISO standard symbols. For mimic configuration, it shall be possible to call up a library of standard symbols

representing items (e.g. pumps, valves) and add new symbols to the library. Building mimics shall be simple and be achieved by using a mouse or tracker ball pointing device.

The mimic displays shall consist of the following pages on a minimum but not limited to:

a) A general diagram covering the entirePumping Stations, any associated systems on a single screen with key data being displayed. The same shall be constituted as Pumping Stations overview screen. The same shall be programmed with complete animation to depict the normal process operation and process media flow within the Pumping Stations system.
b) A general block diagram for each site or area of Site showing the equipment displayed on a series of single screens with key data.
c) Mimic of the equipment and instrumentation connected to each IO module displayed on as many screens as necessary.
d) Individual process screens
e) PLC network monitoring screen
f) Communication interface with CWPS control system and other interfaces as required under this contract.
g) Individual vendor packaged PLC monitoring screen
h) Login screens, reports screen, security screen, overall CWPSscreen, etc. Shall be configured.
i) Screens indicating the current status of each equipment, maintenance schedule/status, Run hours, set points for all equipment inclusive of vendor supplied systems
j) Complete operational screens shall be developed for Pumping Stations SCADA for vendor packaged system irrespective of the vendor system HMI screen supplied if any.

The SCADA software shall have the ability to limit the number of displays being opened simultaneously at any given point of time. The software shall be able to display at least three individual process screens/pop up screens simultaneously and shall be active screens. The contractor during detailed design shall ensure that no two windows/pop up screens of same process shall be opened simultaneously. The above feature shall be displayed during FAT.

- **Trend Displays**

It shall be possible to plot dynamically updated real time data and archived data on a line graph, to represent analogue or digital information. Each graph shall be capable of displaying 8 plots overlaid on a graph of different colors and line texture. Next to the graph, there shall be a key relating each color to its function.

The horizontal axis shall be time based and user selectable in minutes, hours, days, weeks, for example, together with a start time.

The vertical axis shall be scaled as a percentage of range and be displayed in the colour of the selected reading. To avoid cluttering, the vertical axis scale shall be changed by selecting the individual display. The vertical axis shall be automatically scaled for each selected point, between limits entered by the user.

Actual values in engineering units shall be displayed by positioning a cursor at the desired point of the trend graph. The display of the data shall also be available in tabular form.

a) Manual Data Entry:

The system shall be provided with facility for entering data manually via the keyboard. This data will fall into two types:

- Constants which will be changed infrequently. This data may have time and date associated with it.
- Maintenance related comments.

b) Manually Corrected Data:The system shall allow a person with authorized access to correct manually, erroneous data via the keyboard.

- **Reports**

There shall be a real time spreadsheet facility supplied and installed by the Contractor.The users shall be able to transfer data from either the archive system or live data to the spreadsheet.

The user shall be able to produce daily, weekly, monthly and annual reports using any data and a mixture of formats (tables, graphs, summaries, spreadsheets). It shall be possible to generate reports, either automatically at predetermined intervals, or manually on demand by the Operator.

Typical reports on a minimum to be provided but not limited to:

- Flow
- Process parameters
- Pump performance monitoring from the vendor system
- Failures of equipment.
- Clear Water Reservoir levels.
- Discharge pressures.
- Maintenance schedules.
- Power consumption for all equipment
- Process alarm conditions.
- Communication interfaces report between each integrated link/site.
- Status of vendor control packages.

- **Profiling**

From an average, typical or manually entered plot, it shall be possible to set an exception profile whereby readings within an upper and lower level are acceptable. Profiles shall be set graphically via OW.

The user may select for the system to alarm if the reading is outside the profile and highlight such exceptions as part of a report, thereby reducing the need to examine all data, to ensure acceptability. The number of exceptions shall be logged.

- **Data Manipulation:**

It shall be possible to perform simple mathematical functions on any data, including the following functions:

- Addition
- Subtraction
- Multiplication
- Division
- Square root

It shall be possible to log, display or use in a control loop, the resultant data.

- **Database Query Facilities:**

The system shall support the use of database relationships and wild card characters to provide database query facilities. It shall be possible for applications integration to configure queries easily and save them for future use.

Support of Dynamic Data Exchange (DDE) or Structured Query Language (SQL), to permit data exchange between the SCADA and external applications, including spread sheets and databases.

Data shall be presented in tabular format and contain any combination of fields from the main system database. It shall be possible to manipulate the data by specifying search and sort criteria to define data range limits.

Once a query table has been created, it shall be possible to store the configuration and initiate successive look-ups, using a point and shoot technique.

- **Downloading IO Configuration:**

It shall be possible to download configuration to the IO's from the engineering work station and the Portable Programming Unit (Laptop).The same shall be demonstrated during FAT.

- **Diagnostics:**

The system shall have on-line diagnostic facilities to report system faults as they occur. A set of off-line diagnostic routines shall be supplied for more extensive fault diagnosis. The same shall be demonstrated during FAT.

- **Security Access Levels:**

The functions available on the system shall be fully flexible so as to allow users access levels to be customized by the system operator, to suit individual user requirements.

Access to management and engineer levels shall be restricted by user selectable passwords or key switch. The security systems shall be based on a set of privileges, which may be granted or denied to individual uses by the system operator.

Windows functionality of CNTRL+ALT+DEL shall be disabled. On SCADA start-up, the system shall load and directly enter in the SCADA welcome home page. The design shall ensure that SCADA software development page shall not be accessed during the start-up and only on appropriate login access, the same shall be accessible. The same shall be demonstrated during SCADA FAT.

The security/access levels would be divided between Engineers, supervisors and operators.

The system shall be protected from un-authorized changes to the operating system and application programs.

The system shall prevent un-authorized users from re-booting the system or aborting or suspending system-related programs.

The system shall provide three levels of operator access to the system as a minimum, with the first level permitting access to viewing selected Pumping Stations conditions as described below and the highest level intended for the system manager.

A mechanism shall be provided which prevents users operating at a lower level from accessing functions assigned to a higher level.

The system shall provide a password-protected, user log-on facility for definition of the user access level.

Passwords entered during the log-on process shall not be printed or displayed.
The software shall monitor the actions of the user currently logged on at each node and shall log the current user off after a definable extended period of no operator interaction with the system and produce a printed log-off message.

Logging off of the user shall not shut down the system or the SCADA mimic shall not log out. When the operator has logged off, the current SCADA mimic shall be visible for monitoring, but no action shall be possible until the operator has logged in back to the system.

System-generated log messages relating to operator actions, such as alarm acknowledgements or set-point changes, shall include the identification of the current logged-on user.

The Contractor shall provide the following defined user access levels as a minimum and additional levels as instructed by the Employer Representative:

1) **Default Level:**

The default level shall permit users to view all displays except those specifically assigned to a higher level of access.

2) **Operator level:**

The operator level shall permit authorized users to access default level activities in addition to the following:

a) Perform control actions;
b) Acknowledge alarms;
c) Enter or modify manually entered data for inclusion into reports.

3) System manager level:

The system manager level shall permit authorised users to access default level and operator level activities in addition to the following:

a) Modify alarm and control set points, dead bands and time delays;
b) Enter or modify historical data;
c) Add, delete or modify individual I/O points or point attributes;
d) Add, delete or modify field device configurations;
e) Create, delete or modify control algorithms;
f) Create, delete or modify graphic displays;
g) Create, delete or modify system reports;
h) Configure trend displays;
i) Access the operating system;
j) Assign access levels and user passwords;
k) Perform any other system maintenance function

- **Programming:**

The method of programming will depend upon the Manufacturers system requirements. However, the following standards shall be followed:

a) All programs shall be written such that they lend themselves easily to alterations and additions.
b) Good programming practice shall be followed using structured programming techniques. All programs shall be tidy in format and logical to follow. Programs shall be extensively annotated with comments and be self-documenting.
c) The system shall be supplied with programs that use a high-level language.

- **Programme – Documentation:**

As part of the requirements of this specification full documentation is required as below on a minimum:

a) Software user manuals
b) Database point allocation table

c) Complete program listing, flow charts for all sequences and control routines
d) Application software source code (applicable even for packaged control systems)
e) End user license agreements.

- **Control Room Furniture**

In addition to the SCADA system equipment, the Contractor shall provide industrial grade system consoles to complement or match both the colour and styling of the equipment. The Control roomFurniture shall comply with relevant IEC standards for ergonomic design. System console shall be so designed to house all servers, workstations. Monitors, interface equipment with cables having back entry. Details and design of system consoles shall be submitted to the Engineer for review and approval.

Additionally, the Contractor shall provide five ergonomically designed swivel-type adjustable arm chairs with casters, two lockable cupboard with glass doors, three lockable File cabinets to store reports, storage of operating and maintenance manuals, drawings, logger paper, charts, disks and the like. Air conditioning for the complete control room shall be provided. The Calculations for the air conditioning systems keeping in view of the heat dissipation shall be submitted for review and approval.

- **Spares for IOT based IPMS, SCADA**

Contractor shall provide all the services and supplies in accordance with approved procedures for handling of spare parts, which shall include arranging for their proper receipt, stacking and storage for complete IPMS & associated Control & Automation equipments as per below requirement.

Spares for Commissioning & Start-up:

Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioning and start-up spares, special tools and handling gear for each item of equipment.

On a minimum, 1 no. PLC CPU, 1 no. PLC CPU (Vendor supplied package system)1 no. DI Module, 1 no. DO Module, 1 no. AI Module, 1 no. AO Module, 1 No of GPRS communication module, 1 no. RTU of each type (Standalone and redundant type), 1 no of managed Ethernet switches of each type installed,PLC and RTU batteries,30%

fuses of each type and size installed shall be supplied and shall be demonstrated during FAT of the control system)

The same shall be demonstrated during FAT and before commencement of SAT.

Spares list for 1st Year of Operation:

Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioning and start-up spares, special tools and handling gear for each item of equipment.

These items and quantities should be subject to BWSSB's approval. Upon completion of commissioning, contractor shall take inventory and ensure that spares for first year of operation as identified and defined are available on site.

Spares List for subsequent 2 Years of Operation:

Contractor shall identify, define&procure subsequent 2 yrs of operation, spare parts for each item.

PLC CPU Battery-1 No, RTU Battery-1 No.

Spares List for subsequent years of operation

Contractor shall identify, define and procure subsequent years of operation, spare parts for each item of equipment as necessary.

Note: Contractor to include Spare list during their bid submission based on the manufacturers recommendation for each item of equipment proposed.

- **SCADA Hardware**

The system shall support hardware and software interconnectivity to other networks generally in accordance with the ISO Open System Interconnect 7 layer reference model.

2.31 Computers (Workstations):

1) The computer hardware shall be of current technology at the time of installation. Standard server stations, with modern hardware, latest Windows operating system and data transmission over Industrial Ethernet must be used for the engineering workstations. It must be possible to install more than one engineering station in a system. Minimum 2 Tb capacity systems shall be supplied. Theworkstation & monitor shall support minimum screen refresh rate shall be maintained within 4.16 milli secs. The refresh rates shall be 240Hz.The SCADA servers and

workstations, monitors (engineering, operator, and Historian workstations) shall be suitably chosen to meet this requirement.

2) The engineering system must be an open system that, for example, permits the importing of project data from Microsoft Excel, SQL or from CAD/CAE programs. It must be possible to import/export messages to/from Excel and Access for simple processing. Removable memory media must also be provided for each workstation.

   It must be possible to back up all database and configuration data both on removable media and on non-removable storage media without the system being offline.

   Provision of redundant storage media must be possible for the configuration database. The specs for computer hardware shown are indicative only and minimum requirement to be supplied by the contractor.

3) SCADA servers shall be based on latest windows servers operating system

4) All workstations, servers, communications equipment and peripherals shall be from reputed manufacturers, suitable for continuous operation and shall be the most currently available models at the time of construction, subject to approval. Adequate spare capacity shall be included to meet the specified requirements and future expansions. On a minimum, allservers

5) &workstationsinclusive of Historian shall not be loaded more than 60% of their capacity. An alarm shall be generated when this capacity is exceeded. The above feature shall be demonstrated during FAT**.**

6) The system shall support hardware and software interconnectivity to external Programmable Logic Controllers (PLC’s) over an RS-232/RS-485 serial data link using Profibus / Modbus, Ethernet or similar protocol, subject to the approval of the Employer Representative.

2.31.1 Workstations:

Processor	Intel Xeon E3-1220 3.10 GHz v2
RAM	6GB (1 X 6GB) Non-ECC

	configurable Up to 32 GB 1600 MHz DDR3
Storage	2TB SATA HDD
ODD	DVDRW
Graphics	NVIDIA Quadro 2000 1Gb graphics with Dual Display Port, Dual-link DVI and supporting maximum resolution of 2560x1600
Monitor	32” LED 2 in 1 dual Monitor Multiple input .options – DisplayPort, DVI-D and V,Wide viewing angle with native resolution of 1680 x 1050; 16:10 Aspect ratio; 5ms response time ,ENERGY STAR 5.1 compliant, TCO certified Edge 1.1, and Mercury/Arsenic free glass ,screen refresh rate: 240Hz
Ports	(4) USB 3.0 (Rear);(2) USB 2.0 (Front)
Ethernet	Gigabit ethernet
OS	64-bit Latest OS professional version (Minimum)
Warranty	Three-year(Extendableto 7-years),next business day warranty including labour and parts, 24x7support

2.31.2NAS Server (For Historian station as applicable in case of Cloud based application)

Specificati	Minimum Requirement
CPU	Dual-coreIntel®2.4GHzProcessor
	Systemmemory:4GBDDR3RAM
	Memorymodulepre-installed: 4 GBx1
	Total memory slots:4

Memory	Memoryexpandableupto:32 GB (8GBx4)
FlashMemory	512MBDOM
HardDrive	4 x 2 TB SATA6Gb/s
Hard DriveTray	8xhot-swappableandlockabletray
LANPort	2xGigabitRJ-45Ethernetport
	(Expandableupto6x1GbLAN or 4 x 10 Gb + 2 x 1GB LAN by installing optionaldual-port 10 GB and 1 GBnetworkcard)
LEDIndicators	Status,10GbE,LAN,E-sata,harddrives
FormFactor	2U, Rackmount
Expansion Slot	2
Warranty	Three-year(Extendable to 7-years),next business day warranty including labor and

2.31.3 Remote telemetry Unit (RTU):

Specification	Requirement
Dynamic memory (RAM)(program execution, dynamic variables and file system, etc.)	Min 32 Megabytes or more
Program memory (Flash)(for Linux OS, program storage, and file system)	Min 64 Megabytes or more
Data-log memory (RAM) (for data log and retained variables)	Battery-backed – Rechargeable Lithium. The contractor shall provide in his offer, the selection and sizing calculations with reference to the RTU regarding sufficiency of Memory and Processing power of RTU to handle all the specified functions, storage requirements, data-up date speeds, etc. shall be taken care of in the selection and sizing.

Battery-backup time and battery	1yearbackup timeandbatterylife of 10+years
Real-time clock resolution	10Ms
Real-time clock accuracy	+/-15 seconds per month
Data log modes	Trending, alarm log, sequence of events, event initiated, client transfers, and others
IEC 61131programming	Yes
Language support	At least two or more from Ladder logic, function chart, function block, instruction list, structured text, and flowchart
Cycle time	10 ms minimum (user settable)
Communication capabilities	Master, slave, peer to peer, report on exception
Communication	Ethernet(TCP/IP)andRS-485(MODBUS)
Telemetry(built-in)	Built-in GPRS (with4G and compatible with 5G); Incase 5G is unavailable at this point of time, it shall be compatible to 5G in future with minimal downtime to the system operations and no extra cost to
CPU watchdog	CPU automatically resets if error is detected; status LED flashes error code
Ethernet Port	Networkport:1 shielded RJ45connector with Isolation to1.5kVrms/ 1minute Message response time (typical) – 5ms Diagnostic LEDs– (speed and activity) Protocols supported TCP/IP,ARP, UDP, ICMP,DHCP, Modbus/TCP
Serial Ports	Minimum TwonumbersRS232PortRJ45/DB9, at least oneRS485PortwithScrew termination (support for full-duplex and/or 2-wire half-duplex)
Discrete Inputs	No.of channels: As per requirement +30% spares ,withON Voltage 9 to 30VDC, OFF Voltage 0 to 5VDC Input Resistance: 10K Ohms, Input Current @ 24V / 3 mA

Discrete Outputs	No.ofchannels: As per requirement +30% spares (10-30VDC) with Maximum Output per channel of 1amp TypicalONresistance:0.3ohmsand Typical ON voltage (@1A) –0.3VDC
Analog Inputs	No. of channels; As per requirement +30% spares A/D resolution – 16bits (0.003%),Full scale accuracy-+/-0.1% (@20deg.C) Input impedance – 100
Input voltage	10to30VDC (integrated switching supply)
Temperature	-40 to 70°C (-40 to 85°C storage)
Humidity	5% to 95% RH (non-condensing)
Mounting	DIN rail

2.31.4 HMI / PANELPC

Specification	**Requirement**
Front Bezel:	Aluminum w/IP65/NEMA4ruggedprotection
LCD Panel:	Display size 16” colourtouch screen or greater LCD .
	Brightness 350nits
	Resolution 1280 x 1024 pixels
	Viewing Angle80°/80°
	Display Size:16” minimum
Main System:	CPU LGA1155 socket 3^{rd}&2^{nd}GenerationIntel®Core™i7/i5processor
	System Memory 2 x 204-pinDDR3SO-DIMMmax.upto16GB
	Storage 2 x 2.5” SATA HDD
	Drive1xbuilt-inslimDVD-RW (optional)
	WatchdogTimer255levels,1~255sec.
Operating System:	Latest Windows. (Contractor shall submit compliance test report w.r.t various applications,
	3 x RS-232 (COM2-4)
	1 x RS-232/422/485 (COM 1)

IO Connector:	1 x RS-232 with 5V & 12V (COM3)
	1 xDVI-D
	1 xVGA
	6 x USB 2.0(back)
	2 x USB 2.0(front)
	2 x 10/100/1000 Mbps Ethernet
	1 x Audio (Mic-in/Line-out)
Touch screen:	5-wire resistive type
	1millionactivations(typical) at a single point
Power	100 ~ 240VAC,270W
Dimensions:	469 mm (W) x 94.7 mm (D) x 380.8 mm(H)
Environment:	Operating Temperature: 0° ~ +45°C (+32°F ~+113°F)
	Storage Temperature: -20°C ~ +65°C (-4°F ~+149°F)
	Relativehumidity:10~95%@40°C,non-considering
	Operating vibration: 1.0G, 5-500Hz,random
Processing and Memory	The contractor shall provide in his offer, the selection and sizing calculations with reference to the HMI regarding sufficiency of Memory and Processing power of HMI to handle all the specified functions, storage requirements, data-update speeds, etc. shall be taken care of in the selection and sizing.

2.31.5 DC Power Supplies

Specification	**Requirement**
Nominal input voltage	230VAC
Frequency	47 Hz to 63Hz
Input current	3.2 A typ. At 230VAC
Mains failure hold-up time	> 20 mS at 230VAC
Nominal output voltage	24VDC
Output current	10 A at 24VDC
Adjustment accuracy	1%

Degree of protection	IP20
Operational indication	LED green(24VDCo.k.),LED red(overload)
Type of mounting	DIN-rail mounting(DINEN50022)
Ambient operatingtemperature	-10 °C to+70°C
Wire Connection	Cage Clamp
Type	SMPS, shielded metal case, with provision for earth

2.31.6 Intrinsic Safety Barriers

Specification	**Requirement**
Channels	Isolation type IS Barriers, DIN Rail mount
Type	DC version, positive polarity
Nominal resistance	300Ω
Fuse rating	50Ma
Working voltage	Max. 27 V, 26.5 V at 10 µA
Degree of protection	IEC60529
Ambient temperature	-20 ... 60 °C (-4 ... 140°F)
Storage	-25 ... 70 °C (-13 ... 158 °F)
Degree of protection	IP20
Mounting	Standard35mmDINmountingrail (EN60715:2001)
Group, category, type of protection,	II3GExNaIICT4Gc[deviceinzone2]
Directive94/9/EC	EN 60079-0:2009, EN 60079-11:2007, EN 61241-11:2006 , EN 60079-15:2010
IEC Ex approval	IEC Ex BAS09.0142

2.31.7 Surge Protection Barrier

Specification	Requirement
Channels	1-Channel
Rated voltage Un	≤30V
Rated current In	≤250mA
Leakage current	≤5µA
On-state voltage	≤45V
Nominal discharge current(8/20)In	10kApercore,5kApercore(10x)
Max. surge current(8/20) Imax	20kApercore,10kApercore(1x)
Degree of protection	IEC60529
Ambient temperature	-30...80°C(-22...176°F)
Degree of protection	IP20
Mounting	DIN rail mount module
Group, category, type of protection,	Ex II 2(1)G Ex ia IICT6
Directive94/9/EC	EN60079-0:2006,EN60079-11:2007
IEC Ex approval	IECEx BAS14.0010X

2.31.8 ROUTER for 4G / 5G

Specification	Requirement
Important 4Gfeatures	• Auto-switch fail over between primary and backup link
	• Multichannel-interface-processor (MIP) profile configuration
	• Remotely initiated data callback using voice
	• Remotely initiated data call back using Short Message Service (SMS)
	• Remote firmware upgradeover 4G

Dual SIM support	• Virtual diagnostic monitoring
	• Mobile Equipment Personalization (MEP) lock and unlock capabilities
	• SIM lock and unlock capabilities
	• High reliability and cellular multi-homing support for HSPA and HSPA+ based networks
	• Dual SIM card socket; compliant with ISO-7816-2 (SIM mechanical)
	• Two Internal SIM Card Slots:
SMS	• Ability to send and receive SMS (maximum of 160 characters)
3G/4G network manageme ntanddiagn ostics	• In-band and out-of-band management using Telnet (Cisco IOS Software command-line interface [CLI]) and SNMP, including MIB II and other extensions
	• Industry-standard 4G diagnostics and monitoring tools (QUALCOMM CDMA Air Interface Tester [CAIT] and Spirent Universal Diagnostic Monitor [UDM])
Includedantenna	Two multiband swivel-mount dipole antennae (4G) and one extender (4G-AE010-R) to be included Routers.
LED indicators	• Received signal strength indication (RSSI) (green)
	• WLAN
	• WWAN
	• SIM status
	• 3G/4G service (green/amber)
	• SYS
	• ACT
IP and IP services features	• Routing Information Protocol Versions 1 and 2 (RIPv1 and RIPv2)
	• Generic routing encapsulation (GRE) and multipoint GRE (MGRE)
	• Standard 802.1d Spanning Tree Protocol
	• Layer 2 Tunneling Protocol (L2TP)
	• Layer 2 Tunneling Protocol Version 3 (L2TPv3)

	• Network Address Translation
	• Dynamic Host Configuration Protocol (DHCP) server, relay,
	and client
	• Dynamic Domain Name System (DNS)
	• DNS Proxy
	• DNS Spoofing
	• Access control lists (ACLs)
	• Ipv4 and Ipv6 Multicast
	• Open Shortest Path First (OSPF)
	• Border Gateway Protocol (BGP)
	• Performance Routing (PfR)
	• Enhanced Interior Gateway Routing Protocol (EIGRP)
	• Virtual Route Forwarding (VRF) Lite
	• Next Hop Resolution Protocol (NHRP)
	• Bidirectional Forwarding Detection (BFD)
	• Web Cache Communication Protocol (WCCP)
Switch features	• Auto Media Device In/Media Device Cross Over (MDI-MDX)
	• 8 802.1Q VLANs
	• MAC filtering
	• Switched Port Analyzer (SPAN)
	• Storm control
	• Smart ports
	• Secure MAC address
	• Internet Group Management Protocol Version 3 (IGMPv3) snooping
	• 802.1x

Security features	• Secure Sockets Layer (SSL) VPN for secure remote access
	• Hardware-accelerated DES, 3DES, AES 128, AES 192, and AES 256
	• Public-key-infrastructure (PKI) support
	• 20 Ipsec tunnels
	• Dynamic Multipoint VPN (DMVPN)
	• Tunnel-less Group Encrypted Transport VPN
	• Ipsecstateful failover
	• VRF-aware Ipsec
	• Ipsec over Ipv6
	• Adaptive control technology
	• Session Initiation Protocol (SIP) application layer gateway
	• Zone-Based Policy Firewall
	• Stateful inspection transparent firewall
	• Secure HTTP (HTTPS), FTP, and Telnet Authentication Proxy
	• Dynamic and static port security
	• Firewall stateful failover; VRF- aware firewall
	Content filtering:
	• Cisco IOS Software black and white lists
	Integrated threat control:
	• Intrusion prevention system (IPS)
	• Control Plane Policing
	• Flexible Packet Matching
	• Hierarchical QoS (HqoS)
	• Ipv6 addressing architecture
	• Ipv6 name resolution

Ipv6features	• Ipv6 statistics
	• Ipv6 translation: Transport packets between Ipv6-only and Ipv4-only endpoints (NAT-PT)
	• Internet Control Message Protocol Version 6 (ICMPv6)
	• IPv6 DHCP
Memory	
DRAM	At least 512MB
Flash memory	At least 256MB
Interface Support:	
Console or auxiliary port	RJ-45: Single dual-purpose port, which provides direct connection to a console or external modem for management or backup access point
Mini-USB port(RSVD)	Mini-USBporttosupportremote3G diagnostics and monitoring tools (QUALCOMM CAIT and Spirent UDM)
WAN interfaces	• Wireless WAN with 3G,3.5Gand 3.7Gspeeds
	• 10/100/1000 Giga bit Ethernet port
LAN interfaces	• Four 10/100 Fast Ethernet ports
Standard safety	• UL 60950-1, 2nd edition

- **Broadband Internet**

Broadband internet services with high speed connectivity shall be supplied for connectivity with centralized SCADA center and for web connectivity. The most suitable package of broadband internet service provided by an Internet Service Provider (ISP) which suits the Client’s requirement shall be utilized. The contractor shall enter in to SLA agreement to provide continuous fail safe services as required under this contract.

- **Fixed Line**

For locations at where ISP is readily available, the technology which supports the broadband services shall be based on Digital Subscriber Line (DSL). The type of DSL utilized shall be of the Asymmetrical Digital Subscriber Line (ADSL) which shall allow simultaneous access to the net and usage of the telephone or fax line Certified

ADSL modems shall be utilized. Splitter and micro filter shall be installed on the telephone or fax line to avoid interference.

- **Monitor**

1) Visual Display Units (VDU's)/Monitor shall be 2 in 1 dual color monitor screens with required monitor stand to support dual functionality, capable of displaying information in alphanumeric, bar histogram, graphical and mimic diagram formats. 2 in 1 dual monitors shall simultaneously display a minimum of 256 colors, non-interlaced, low radiation, flat screen with no discernible flicker. Display of characters shall be legible and stable on a shadow mask tube, having a resolution of not less, so that 1024 by 768 pixels and a refresh rate of not less than 240 Hz. The units shall include all the necessary picture controls to adjust the sharpness, contrast and position of the image. LED VDUs shall be flat screen, minimum requirements: brightness 250 cd/m2, 500:1 contrast ratio, 1600 x 1200 pixels.
2) VDU's shall be 32 inch LED Screens on a minimum.
3) VDU's shall be fitted with a power management system to reduce consumption upon detection of a stand-by signal from the PC.
4) Note: Each SCADA server, engineering and operator workstation, Historian system, CCTV system shall be provided with VDU units as described above.

2.32 Printer

2.32.1 Colour Multifunction Printer:

Color Multifunction printer shall be used for the production ofcolor screen dumps and reports and shall have a sufficiently sized buffer memory such that system performance will not be degraded when the color printer is operational and comply with the following:

Printer Specification:

All-in-one functions	Print, copy, scan, fax, standalone scan-to email, photo card slots
Multitasking capability	Yes.
Paper Size	A3,A4

Print speed, black (normal quality mode)	Up to 21 ppm
Print speed, color (normal quality mode)	Up to 21 ppm
Print speed footnote	Exact speed varies depending on the system configuration, software program, and document complexity.
First page out (color)	As fast as 17.9 sec
Monthly duty cycle	Up to 40,000 pages
Footnote for duty cycle	Duty cycle is defined as the maximum number of pages per month of imaged output. This value provides a comparison of product robustness in relation to other LaserJet or Color LaserJet devices, and enables appropriate deployment of printers and MFPs to satisfy the demands of connected individuals or groups.
	Paper Heading:
Paper handling standard input	50 sheet multi-purpose tray 1, 250-sheet input trays 2 and 3, 50-sheet ADF
Paper handling standard output	150-sheet face-down output bin
Envelope capacity	Up to 30 envelopes
Envelope feeder	No
Duplex printing (printing on both sides of paper)	Automatic (standard)
Document finishing	Sheetfed
Media sizes, standard	Letter, legal, executive, envelopes (No. 10, Monarch)
Media sizes, custom	Tray 1: 3 x 5 to 8.5 x 14 in; Tray 2, Tray 3: 3.94 x 5.83 to 8.5 x 14 in
Media types	Paper (bond, brochure, colored, glossy, letterhead, photo, plain, preprinted,

	prepunched, recycled, rough), transparencies, labels, envelopes
Media weight	Tray 1: 16 to 47 lb (up to 58 lb with Color Laser glossy photo papers); tray 2, tray 3: 16 to 43 lb (up to 47 lb with postcards, up to 58 lb with Color Laser glossy photo papers)
Weight	71.2 lb
Processor speed	450 MHz
Memory, standard	160 MB
Memory, maximum	416 MB
	Scanner Specification:
Scanner type	Flatbed, ADF
Scan resolution, optical	Up to 1200 dpi
Bit depth	42-bit
Scan size, maximum (flatbed)	8.5 x 11.7 in
Scan size, maximum (ADF)	8.5 x 14 in
Scan speed (default)	Up to 15 ppm
Automatic paper sensor	No
	Copier Specification:
Copy speed (black, best quality, A4)	Up to 20 cpm
Copy speed black (best, letter)	Up to 20 cpm
Copy speed color (best, letter)	Up to 20 cpm
Copy resolution, black	Up to 600 x 600 dpi
Copy resolution, color	Up to 600 x 600 dpi
Copy reduce/enlarge settings	25 to 400%
Maximum number of	Up to 99 copies

copies	
	Fax Specification:
Faxing	Yes
Fax transmission speed (seconds per page)	3 sec per page
Fax memory	Up to 250 pages
Fax note	Based on standard ITU-T test image #1 at standard resolution. More complicated pages or higher resolution will take longer and use more memory.
Fax resolution, black (dots per inch)	Up to 203 x 196 dpi
Speed dials, maximum number	Up to 120 numbers
Auto redial	Yes
Fax delayed sending	Yes
Fax broadcast	119
Junk fax barrier	Yes
Polling	Yes (receive only)
Remote retrieval	No
Fax forwarding	Yes

2.33 Uninterruptible Power Supply (UPS) for complete Instrumentation, Control & Automation

The UPS shall be floor mounted; self-contained and metal clad and shall be suitable for supplying a non-linear load. It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact to touch.

The UPS shall be an on-line type incorporating a six pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch which shall operate in the event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

The UPS shall incorporate a dc under voltage trip circuit to electronically trip the UPS output in order to protect the batteries.

The noise level of the unit shall not exceed 60dB(A) at 1 mtr from the UPS cabinet.
The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non-linear load. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

The unit shall have a dynamic response such that a 100% step load causes an output voltage transient of less than ± 4% with a recovery time of less than 4 ms.
For three phase output units the output voltage shall not vary by more than ± 1% for an unbalance of 10%.

The load crest factor shall not be less than 3:1.

The efficiency at full load and 0.8 power factor shall be greater than 88%.

The UPS System shall communicate the following status data to the Pumping Stations SCADA system to monitor: (Note: To be demonstrated during FAT)

- UPS status
- UPS alarm conditions
- Battery capacity
- Bypass status
- Fault

The UPS shall provide a volt free contact output to indicate:

- warning, i.e. low battery capacity
- fault
- static bypass in use.

The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.

The batteries shall be housed, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS. The UPS battery shall be located in a well ventilated area.

2.33.1 Technical Particulars:

Each UPS shall have the following features:

a) The UPS shall be stand alone, true on line, based on advanced IGBT PWM technology with microprocessor based control, monitoring and fault diagnostics, static by pass switch and front access oriented layout.

b) Main Parameters:

1	Input Voltage	415V +10% -15 % A.C. Three phase 4 wires with Solidly earthed Neutral.
2	Symmetrical Short circuit level. Frequency	25kA 50Hz ± 5%
3	Output Voltage	240 ± 1% A.C, Three Phase 4 wire with Solidly Earthed Neutral.
4	Frequency Wave form	50Hz ± 5% True Sine Wave
5	Isolation	True on line with complete galvanic Isolation
6	Total harmonic Distribution	< 2% for linear load, < 3% for non-linear load
7	Over load Capacity	125% for 10min 150% for 10Sec
8	Transient Response	Remain within ± 1% and recover to 100% within ¼ Cycle
9	Crest factor	3 : 1
10	Duty	Continuous
11	Static by pass	to be provided
12	Efficiency Converter Inverter Overall	 > 94% > 93% > 87%
13	Max Ambient Temp and Relative Humidity	45°C & 100%
14	Cooling	Forced air

15	Acoustic Noise Level	<60db at 1.5m
16	Battery backup	60min for full load.

c) The UPS shall be complete with Isolation transformer, Converter cum Changer, inverter, protections, indications, programming, microprocessor-based monitoring and fault diagnostic system, communication facilities, redundant control power supplies, SMF battery, accessories and interconnecting Cables.

d) Constructional Features: The UPS shall be high quality CRCA sheet steel enclosed suitable for floor mounting. The sheet steel shall be of 2mm thick. All sheet parts shall undergo phosphating process to ensure anti rust conditioning and superior finish. Premier quality powder coating shall be applied. The degree of protection shall be IP 54. The UPS panel shall be provided with two earthing terminals. The final finish shall be Light Grey Semi Glossy Shade 631 of IS 5.

2.33.2 Converter cum Charger:

When normal AC supply is available, DC power for the inverter is fully supplied by the converter and the battery is kept under float charge. On main supply failure, the battery shall be automatically connected to the Inverter without interrupting the output voltage for critical load. Similarly on normalization of AC power, the DC load shall be transferred to the converter and battery shall be put on float charge without interruption at output side. The converter cum charger shall be designed to deliver the full load DC required by the inverter and charging of the battery. Battery charging shall be with float & boost mode selection with current limit.

1) **Inverter:**

The static inverter shall convert the power from the converter/battery into stable AC power which is supplied to load. The inverter shall be with the latest IGBT PWM technology with specially designed output transformer.

2) **Battery Bank:**

Batteries shall be 12V, SMF (sealed maintenance free) type. The Qty & AH of batteries shall be suitable for backup period of 120 minutes for full load.

The battery shall be rated to provide full load power for required backup time on AC power failure. After delivering this amount of power, the battery shall be suitable for recharging through converter cum charger on AC power restoration. The battery shall be mounted on a separate rack. The battery bank shall be complete with battery stand, interlinks and UPS to battery interconnecting cable.

The battery bank shall be installed in a separate room with good ventilation in the administration building.

3) **Other features:**

The other features of UPS shall be as follows:

i) Microprocessor based Control, monitoring and fault diagnostics.

ii) Comprehensive LED mimic and LED display with keypad Control to enable the following:
   a) Date-time stamped event recording and logging in a non-volatile memory
   b) Programming and Monitoring of various system parameters
   c) Status indications and number of LCD digital meters.

iii) 100% Nonlinear local handling Capability with low distortion of less than 5% and high crest factor of 3:1

iv) RS 232c/ RS 485 interface port.

v) Front access layout.

vi) Inbuilt line chokes for main power supply.

vii) Indications:
- Mains ‘ON’
- Converter ‘ON’
- Inverter ‘ON’
- Battery Low
- Over load
- Inverter Trip
- Charger Trip
- Output ‘ON’

viii) Protections:
- Incomer MCCB with Overload & Short circuit releases
- Outgoing MCCB with Overload & Short circuit releases
- Battery MCCB with Overload & Short circuit releases

- Input under/over voltage
- Converter over voltage
- Battery Low
- Battery charging current limit
- Output under voltage
- Output over voltage
- Output over load
- Output short circuit
- Inverter over temp
- Single phase prevention

Alarm and trip conditions shall be separately enunciated.

The backup period shall be minimum 2 hr on full load.

Testing Requirements

The Contractor shall carry out specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.

The Contractor shall demonstrate the following on a minimum:

- change-over from full load with mains present to full load on battery supply;
- carry out a discharge test on the system at full load and for the specified duty bridging time period;
- carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.
- Demonstrate the full functioning of the PLC& SCADA system while running on UPS power.
- All Routine/acceptance tests as per relevant Indian / International standards shall be carried out in the presence of Employer / his Employer Representative.

2.34 Quality Assurance/Quality Control (QA/QC):

QA/QVC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for IPMS & associated

Automation System, necessary Instrumentation, PLC-SCADA, accessories, systems and other equipment that shall comprise the instrumentation and automation system under this contract. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Insulation and High Potential Testing;
- Complete functional test inclusive of data interfacing with third party system for monitoring;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;
- All other documentation required by applicable codes and standards.

2.35 SCADA Control Room design

The existing SCADA Control Room shall be utilised wherein all the general considerations are being taken care by others. Contractor to visit the site & conduct survey to make out the needful requirements related to the Control Room in line with tender requirement.

As part of this contract Control Room shall be provided with air-conditioning systems as per quantity indicated in the BOQ / Technical Schedule.

The SCADA control room is equipped with false flooring to provide access for all cables or similar arrangement for Cable Laying is already available at all 3 Pumping Stations. Contractor to verify the existing cable laying arrangement, availability of sufficient space for new Cables, trays etc.

No cables shall be installed over the control room floor.

Apart from this Control Room shall be modified to accommodate System Hardware including Console for workstation, Printer Table, furniture, Chairs, LVS etc. and same shall be indicated in Control Room Layout along with existing hardware.

2.35.1 General Design Considerations

An ergonomic approach to the design of centralized Local monitoring center and the layout of the control room shall contribute to achieving safety and performance objectives set for the centralized Local Monitoring room.

Effective control room design shall consider safety and performance / aesthetic objectives and function to create workspaces that facilitate the complex interaction between operators, technology and the environment., acoustic concerns, indirect lighting and the wellbeing, health and safety of each operator shall need to be addressed.

Operators in the control room shall work 24 hours a day, 7 days a week.

Control room design shall take into consideration room size, number of operators, viewing requirements and equipment. Operators shall be able to communicate with each other as well as have easy access to essential equipment. The height of the console shall be calculated so the shortest operator can see over the top of any workstation mounted electronics to remote monitor walls, control panels or displays and the clearance underneath the work surface should allow for the tallest operator to sit comfortably.

The contractor shall design the control room based on international accepted standards taking care of the aesthetics and operator comfort and Pumping Stations view. The Control room aesthetics design shall be submitted for review and approval before any design of the control room is taken up.

Additionally the contractor shall include cable routes and cable trays/cable gallery to route the cabling from the main pipeline to the SCADA control room.The same shall be indicated in the cable routing layouts, SCADA control room layouts, etc, as applicable.

When designing the control room to address these and other concerns, the following steps shall be taken to ensure operator comfort and minimize fatigue:

- Test console layout with operators for “human tasks” including sequential task simulations.
- Develop workstation layouts designed around acceptable reach zones and visual limitations.

- Take into account maintenance requirements and removal of equipment from both the rear and front of the workstation.
- Provide ergonomic footrests where appropriate.
- Provide 24/7 chairs with full adjustment capabilities.
- Reduce excess heat and noise by locating electronics in an equipment room.
- In workstation dimensions, consider the full height and size range of the operators, utilizing height adjustable work surfaces where appropriate.

SCADA control room shall be designed to have maximum view of the Pumping Stations and Pumping Stations operation. The brick masonry works in the control room shall be replaced with full length glazed windows with access control system.No UPS system shall be installed in the control room. A separate UPS room with battery room shall be provided for the purpose.

The SCADA control room shall be provided with air conditioning system.The temperature in any area of the control room shall not exceed 22deg C.

2.35.2 Electrical& Earthing Requirementsfor SCADA control Room

SCADA Control room Power distribution system shall have redundancy at two levels. The electrical system shall be designed to incorporate spare capacity (Minimum 20%) at each distribution level. All wiring up to the SCADA Control room shall be laid in powder coated MS conduits / Aluminum raceway.

All power cables up to the SCADA Control room shall be PVC insulated type. All cables shall be armored cable type except where flexibility required does not permit use of armored cable.
Earthing system shall be as per IS – 3043.

Contractor shall design and implement anti- static EMI / RFI protection arrangement, wherever necessary.

The contractor shall design, engineer, supply/manufacture, test, erect, install, connect; commission and site test the Electrical Distribution System for any and all

power requirements within the SCADA Control room facility. This shall include, but not be limited to UPS, ACDB system and input power to various sub systems of the Server/SCADA Control room like cooling units, alarm systems etc.

Design, engineering, supply, section, wiring, commissioning and testing of all systems are in the contractor scope. Contractor shall design, engineer, supply, commission and test the electrical system considering the various loads it has to cater to.

The technical specifications and the scope for various items provided herein need to be verified by the Contractor. Contractor's scope shall include end to end system that is designed and implemented according to various applicable standards / regulations and meets total requirement for the Server/SCADA Control room Facility.

Copper earth pit station as per IS - 3043 using 600 X 600 X 3 mm copper earth plate complete with accessories and hinged cover shall be provided by the Contractor. Another earthing system shall be extended for equipment body earthing of SCADA control room, using 25 X 3 mmGI strip. Two Earthing pits shall be provided for UPS Earthing, which will be interconnected, and same grid will join the building-earthing grid at only one point. Earthing System shall be designed & maintained considering personnel safety and noise-resistant electronic environments by providing equi-potential bonding with earth resistance of less than 3 ohm. Contractor shall design, supply and implement the most efficient and safe earthing system considering the types of load, fault conditions, cross current circulation, spikes, circulating current due to potential differences, etc.

The earthing system implemented shall ensure safety of people and systems under all conditions. Earth fault protection shall be designed and implemented by the Contractor for all loads.

2.36 Inspection & Testing Requirements:

A. Inspection and Testing Requirements for Instrumentation works

(a) Inspection, Testing and Setting to Work — General

Each item of IPMS& associated Instrumentation & Automation System shall be subjected to the manufacturer's own tests which shall be certified. Each item of Pumping Stations and its installation shall be subject to inspection and testing at the

place of manufacture. The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of Pumping Stations and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense. The contractor has to get approval from the client's representative for the training personnel to be employed by the contractor.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

(b) Preliminary Inspection and Testing at the Place of Manufacture

i. Field Instruments

After the successful completion of the manufacturer's own inspection and testing of instruments to be supplied under the Contract, similar tests shall be carried out in the presence of the Engineer, engineer's representative and the Contractor at the manufacturer's factory where the instruments have been manufactured. No deviation on the same shall be acceptable. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points. Complete functional testing of all instruments (Field instrumentation inclusive of pump performance monitoring system)

ii. Field based Consoles, Instrument panels, enclosures and mounting boards

The manufacturer shall not present instrument panels, enclosures, junction boxes and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies may then be witnessed by the Engineer, engineer's representative. The Contractor shall give not less than 7 days' notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract this shall take precedent.

The witnessed inspection and testing shall include the following on a minimum:

a) Complete functional testing of the instrument inclusive of calibration and sampling system (applicable for all field and analytical instruments):
b) A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification;
c) A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring or piping;
d) That all engraving and labels are correctly positioned, fixed and designated in accordance with the Specification;
e) Panel power-distribution circuits have the correct breaker/fuse rating coordination and designation;
f) Power-isolation facilities meet the Specification;
g) The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates;
h) The output of all power supply units again at the beginning and end of the testing with results being recorded;
i) The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate;
j) The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance

tests and these tests being carried out in accordance with IEE Wiring Regulations;

k) That the clean earth bar is isolated from main frame of the panel. Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with the Specification. Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunking and provision for additional cable entry

(c) Functional Testing at the Place of Manufacture

General requirements

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence in the presence of the employer and employer's representative for 100% quantity of all equipment. The purpose of the functional tests are to demonstrate that all instruments and pump performance monitoring system instruments, panels' enclosures and mounting boards (assemblies),sampling system conform to requirements of the Specification. Functional testing on a minimum shall include, calibration check as per established international standards, transmitter function check, error reporting, alarm functions, communication check with external third party devices, etc.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out.

The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witness signatures. All applicable drawings and data shall be provided at the place of inspection by the Contractor.

The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.

The following is a typical list of the equipment required:

- Switch boxes;
- Indicator light boxes;

• Analogue signal sources;
• Dummy loads;
• Meters;
• Simulators;
• Desk-top computers;
• Programmers for PLC or outstations;
• Insulation test equipment.

(d) Quality Assurance/Quality Control (QA/QC)

QA/QC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for ICA systems including IPMS. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Calibration check:
- complete functional testing of equipment along with sampling system(as applicable):
- Insulation and High Potential Testing;
- Packaging and Shipping;
- Welding;
- Communication, standard protocols
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;
- All other documentation required by applicable codes and standards.

B. Inspection and Testing Requirements for Control &Automation works

a) Factory Acceptance Test (FAT)

The Contractor shall conduct a full programme of tests of the IPMS and associated automation system based on RTU or PLC & SCADA system at the manufacturer /system integrator testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full

compliance with the Specification. Unless otherwise specified or agreed by the Engineer, the entire PLC & SCADA system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 7 days before the scheduled factory acceptance test, the Contractor shall give written notification to the Engineer that a complete dry-run of the factory acceptance test has been performed successfully and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer or unless otherwise approved by the Engineer. Delay in the delivery of the system due to failure of the factory acceptance test shall not constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site.

The entire cost of the complete FAT and any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB& employers representative personnel attending the tests, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

C. Inspection and Testing Requirements for Pump Performance Monitoring System

A. Factory Acceptance Test (FAT)

The Contractor shall conduct a full programme of tests of the pump performance system including Cloud based intelligent Platform at the manufacturer testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full compliance with the Specification. Unless otherwise specified or agreed by the Engineer, the system shall be assembled and tested together as an integrated system, including all station equipment, all operators' consoles, included as specified in this Specification to demonstrate the complete functional testing of the system.. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 7 days before the scheduled factory acceptance test, the Contractor shall give written notification to the Engineer that a complete dry-run of the factory acceptance test has been performed successfully and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer or unless otherwise approved by the Engineer. Delay in the delivery of the system due to failure of the factory acceptance test shall not constitute an

unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site.

The entire cost of the complete FAT and any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB& employers representative personnel attending the tests, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

Performance Testing of Bought items for IPMS like sensors shall be carried out during FAT / SAT of the IPMS.

Note: The contractor shall ensure that the IPMS after testing at the IPMS & associated control system's manufacturing facility where the equipment is manufactured, is also tested along with the Pumping Stations pumps where the IPMS is to be installed. Both the pumps and the IPMS shall be tested in unison to check the functionality of the entire combined system. Contractor shall note the importance of this functional testing of the system and include the same in the QAP.

b) Factory Acceptance Test Procedures

1) General

The scope of the tests shall include the proving of every aspect of hardware and software operation and functions as detailed below.

2) Hardware tests

(a) Verify the correct inventory of hardware including cables and printed circuit boards;

(b) Demonstrate that all spare-memory, disk-capacity and system-expansion requirements have been met;

(c) Demonstrate all hardware and software diagnostics;

(d) Verify all power supply voltages are within tolerance;

(e) Verify proper earth connections and isolation of instrumentation earth for all equipment;

(f) Demonstrate operation of test simulation and indication equipment and its Suitability for adequate functional testing of all system functions.

3) Software tests

(a) Demonstrate the editing of all system parameters including set-points, timers and the like;

(b) Demonstrate system configuration capabilities including the addition and deletion of input and output points, outstations, and all data base parameters;

(c) Demonstrate the addition, deletion and modification of mimic displays and report formats;

4) Functional tests

The functional tests shall verify proper operation of every specified system function as an integrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and control panels as specified elsewhere. All failures or discrepancies found shall be documented in the test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall be the decision of the Engineer whether the factory acceptance test is to continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a system modification document, signed by both Contractor and Engineer and be incorporated into the final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by the modification.

The functional tests shall include, as a minimum, the following:

a) Demonstration that the system meets the requirements of the Specification for response time and speed of screen update
b) Verification of the accuracy of all Sensor input points in the system. The procedure shall include applying the appropriate signal to each analogue input at a minimum of three points within the range of the input, checking for expected numerical results, and verifying appropriate update of related mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also be verified

c) Verification of the proper logic sense, pulse accumulation and rate computation where appropriate, of all digital inputs and verifying appropriate update of related Screen displays;

d) Verification of all control and sequencing operations and proper operation of all digital and analogue outputs. The procedure shall include simulation of all related process variables for both normal and abnormal conditions, including instrument and component failure, and demonstration of fail-safe response of the system. System outputs shall be indicated with appropriate lamps and indicators;

e) Simulation of outstation communications errors and failures and demonstration of error detection and handling, failure detection and handling, and appropriate changes to control actions as designed and specified;

f) Verification of fault detection and diagnostics by inducing a sufficient variety of fault conditions in the system to ensure that detection processes and fail-safe operation are adequately tested;

g) Demonstration of proper operation of all Screen displays, help pages, reports, operator procedures and historical data accumulation;

h) Demonstration of proper operation of all outstations following a simulated master station central processor failure;

i) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backup of all hardware for the full length of time specified, and proper operation of power fail, low voltage warning and all associated alarms.

j) Demonstration of proper remote monitoring from Web application & also through Mobile Applications (Alarm monitoring, escalation levels).

5) Reliability test

After successful completion of the functional tests a 48-hour continuous run of the system shall be performed. The test shall be passed if no system function is lost or no hardware or software failure occurs. Hardware failure is defined for this test as the loss of a major component such as the computer, Pump monitoring console, a VDU or a peripheral device. Non-repetitive mechanical failures of loggers, push-buttons and the like are excluded.

During this test, the system shall be exercised with simulated inputs and conditions in a manner which approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance test documentation.

c) Factory acceptance test documentation

As a minimum, the following information shall be included in the factory Acceptance test manual for each test:

• Test identification number;
• Test name and description;
• List of all equipment to be tested including any special test equipment required;
• Description of the test procedure broken down into logical steps;
• Description of the expected system response verifying the completion of each logical step;
• Space for recording the results of the test and the time and date of the test;
• Space for signatures of the Contractor and the Engineer.

In addition, the Contractor shall provide a method for recording and tracing all problems, discrepancies, queries and suggestions regarding the system and software, and for formalised control of any modifications to the system.

d) Pre-commissioning tests

The Contractor shall perform pre-commissioning, or preliminary, testing of the IPMS & associated Control System components including sensors on pump-motors, field instrument etc. in accordance with that specified for instrumentation. The purpose of pre-commissioning tests is to confirm readiness of the system for commissioning.

The scope of pre-commissioning tests shall be generally as specified for factory acceptance tests but real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Where this is impractical, simulation signals shall be injected as near as possible to their ultimate sources so as to include in the tests as much of the cabling system as possible.

Each process system shall be set to work under manual control and the system tested to confirm proper operation. After proper operation of manual control mode has been verified, tests of automatic controls of each process system shall be conducted wherever practical.

e) Site Acceptance Tests (SAT) including functional check of Cloud Based Pump Monitoring intelligent Solution demonstrating features like Machine Learning, Digital Twin etc.

The Contractor shall submit all relevant draft operating manuals for the IPMS & associated SCADA System to the Engineer for approval prior to commissioning tests. Any faults or failures of the system detected during the previous tests shall be noted and corrected to the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning, control and instrumentation system (the PLC & SCADA system, pump performance system and the entire communication system) shall be tested for availability for a continuous period of Sixty days. The control and instrumentation system shall be subjected to SAT only after the complete Pumping Stations electro-mechanical and ICA works have been completed and tested to perform as per contract requirements and both manual and auto mode of cloud based intelligent Platform has been completely tested and found to be as per contract requirements. During this period, the system will perform the normal functions according to the procedures described in the SAT documentation approved by the Engineer.

The system shall have passed the SAT if all major components have been free from fault or failure and exhibit full error-free functionality for 100 % of the total duration of the test, unless otherwise agreed by the Engineer. Major components include all master station equipment, outstations, communications facilities and instrument panel components, excluding push-buttons, switches and lamps and any equipment not supplied by the Contractor.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re-configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availability test. Any changes to the system which are required and approved shall be described in a system-

modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final test documentation. The test shall be restarted after corrections have been made.

2.37 Training Requirements for Instrumentation, control and Automation works

A. Before Conduction of Site Acceptance Test(SAT)

The system supplier shall conduct training courses for personnel selected by BWSSB. Training shall be conducted by personnel employed by the Contractor/ system supplier familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

Training shall be conducted for a minimum period of 3days for at least five BWSSB personnel on each site, by the system suppliers (Field instrumentation, IPMS, Process equipment suppliers (vendor supplied systems), Pumping Stations operations, Control & Automation systems, Surge vessel systems, etc

The entire cost of the complete training programme, including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB personnel attending the training program, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.
The Contractor/ system supplier shall submit information on the training programme for approval, prior to shipment of the equipment. This submittal shall include a course outline; time required, course schedule, sample workbook and instructor qualification information for each level.

The Contractor/ system supplier shall make a workbook on each course available to every person taking the courses listed herein. The workbook shall be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

The training times shall be scheduled by the BWSSB in advance with the Contractor/ system supplier so as not to disrupt the BWSSB’s ability to operate the Pumping Stations.

B. After Conduction of Site Acceptance Test(SAT)

Training shall be provided for Ten (10) nos. of the BWSSB personnel of the each CWPS facility at respective pumping station on operations and maintenance of all system components. The training program shall be divided into two segments and shall consist of at least 7 (Seven) working days, each of 8 (eight) hours duration.This shall include (Field instrumentation, IPMS, Process equipment suppliers (vendor supplied systems), Pumping Stations operations, Control & Automation systems, etc

The maintenance training program shall be developed for personnel that have electronics maintenance and repair experience and a general knowledge of IPMS& associated computer& communicationsystems but shall not assume any familiarity with the specific hardware furnished.

As a minimum, the following subjects shall be covered:

IPMS, PLC-SCADA System's

System Architecture and Layout

Hardware Components

Module Switch Settings (Configuration Switches)

I/O Modules

Power Supplies

Data Highway:

Programmer connection

Programming and diagnostic techniques

Battery replacement and recharging

PC and workstation familiarization and maintenance:

Troubleshooting

Component Replacement

Re-assembly

The operation training programme shall include the following topics:

Power-up, bootstrapping and shutdown of all hardware devices

Interpretation of all standard displays

Appropriate actions for software and hardware error occurrences

Use of operator interface displays and keyboards

Use of printer including replenishment of supplies

Manual data entries

Creation and editing of graphic operator display screens.

Loading of any required software into the system

Data base creation and editing.

End of Part - 2